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ENGINEERING NEWS-RECORD

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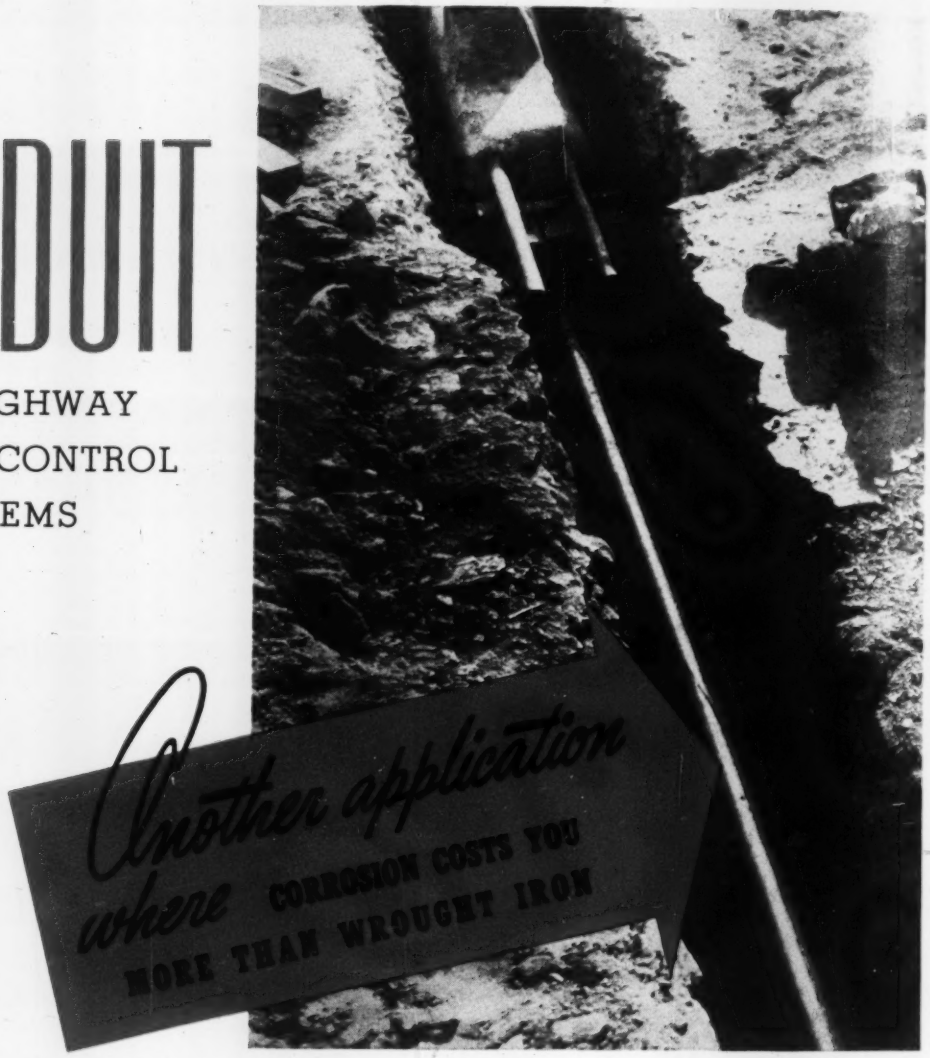
NORTH BEACH AIRPORT
THE NATION'S No. 1 TERMINAL

CONDUIT

FOR HIGHWAY
TRAFFIC CONTROL
SYSTEMS



BYERS WROUGHT IRON

Conduit for electrical cables is often exposed to highly corrosive conditions in the atmosphere, underground, or underwater, and to physical stresses from vibration and shifting overburdens as well. Many municipalities encounter these problems when highway traffic control systems are installed. Fortunately, experience points out an easy and economical solution which was applied in the newest type of completely automatic "metered" control installed by the County of Essex, New Jersey. Byers 2" galvanized wrought iron pipe was used for conduit.

Many cities and utilities have for years used wrought iron conduit in applications where severe corrosive conditions are involved. 16,877 feet of Byers 3½" black wrought iron was installed the latter part of 1929 under the Calumet River to carry telephone cables. 17,500 feet of Byers 4" extra heavy black wrought iron are used to carry high tension lines under the Harlem River. Chicopee, Mass., installed Byers 3½" black wrought iron pipe to carry cable from underground lines to the overhead lighting system. And extensive use has been made of wrought iron in conduits carried on bridges.

Byers Wrought Iron Pipe for conduit use is furnished plugged and reamed, and fitted with threads and couplings particularly adapted for this service. If you have a problem of conduit selection or maintenance and will write us the details, our Engineering Service Department will be glad to give you any information on similar installations which we have in our files, and to make recommendations —supported by service records.

A. M. Byers Co., Pittsburgh, Pa. Established 1864. Boston, New York, Philadelphia, Washington, Chicago, St. Louis, Houston, Seattle, San Francisco.

BYERS GENUINE WROUGHT IRON

TUBULAR AND FLAT ROLLED PRODUCTS

Specify Byers Genuine Wrought Iron Pipe for corrosive services and Byers Steel Pipe for your other requirements

ENGINEERING NEWS-RECORD

Devoted to Buildings, Sewers, Waterworks, Bridges, Highways, Streets, Dams, Foundations, Earthwork, Flood Control, Public Works, Irrigation, Canals, Railroads

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THIS WEEK

● Focal point of Pittsburgh's business activity is its famous Golden Triangle, the point of land formed by the confluence of the Monongahela and Allegheny rivers. On the Monongahela side the first leg of a project to surround the triangle with a motor vehicle express belt line is now being rushed. A description of the structural features of the new route, which is an elevated, surface and depressed road rolled into one, begins on p. 42.

● New York City's sanitary landfill fight has received a lot of attention in *News-Record's* pages during the past year and a half. Now a board of experts has endorsed the methods used. Recommendations for best practice are given on p. 54.

● When the greatest air terminal in the United States and probably in the world—North Beach at New York City—is completed, its design and construction constitute vital information for engineers and construction men. This issue gives that information in a special 12-page section written by the man best qualified to present it—Lt.-Col. Brehon Somervell of the Army Engineers, and WPA Administrator for New York City.

THINGS TO COME

FOR MANY YEARS through motorists have shunned Cleveland because of the hours that could be lost in its congested thoroughfares. Now, however, the old situation is well on the way to its rightful place in the traffic engineer's history book, for across the meandering Cuyahoga River and its bottom lands has been built the new $7,200,000 Main Ave. Bridge, vital link in the city's lakeside boulevard system. An article on the project will appear April 11.

PROGRESS tomorrow comes from the innovations of today. This is the theme of a special section on water supply emphasizing recent innovations in practice, which will be published in the April 11 issue. Waterworks men (and others, too) will find opportunity to make a stimulating excursion among developments, all of which are novel and most of which show promise of becoming standard practice.

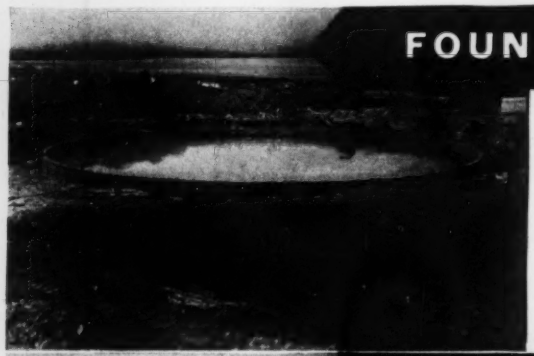
Save days and dollars

ON ALL KINDS OF JOBS

WITH ATLAS HIGH-EARLY CEMENT!

THE three jobs below show how many a concreting job can be done quicker, and frequently at less cost, with Atlas High-Early cement! That's because concrete made with Atlas High-Early gains strength rapidly. It is ready for its load often within 24 hours of placing. This may cut down labor and overhead cost; cut curing and protection time costs to less than half. Also it often allows earlier stripping and re-use of forms, cutting down the number of sets needed.

So try Atlas High-Early cement on your next job. You'll find it often pays back its slightly higher cost—over and over again! Universal Atlas Cement Co. (United States Steel Corporation Subsidiary), Chrysler Building, N. Y. C.



FOUNDATIONS—12 DAYS SAVED!

Tank foundations built for Rayonier Inc., a paper mill in Ferandina, Fla., with Atlas High-Early cement. Concrete placed in both tanks in one continuous operation. Placing took, in first foundation, about 5 hours; in second about 8 hours. Use of Atlas High-Early saved 6 days on each foundation. Engineer, Central Engineering Co., Port Angeles, Washington; Contractors, Rust Engineering Co., Pittsburgh, Pa.

BRIDGE—9 DAYS SAVED!

Reinforced concrete county bridge in Schuylkill County, Pennsylvania. Original specifications called for removal of forms in 14 days. But, by using Atlas High-Early cement in parapet, deck, and one span, forms were removed in 5 days. Altogether, 9 days were saved and form costs were cut by using Atlas High-Early. Engineer, Robert Shank, Court House, Pottsville; General Contractor, C. L. Miller, Pottsville; Sub-Contractor, John Starr, Herndon, Pa.

PILES—10 DAYS SAVED!

Piles for foundation of East Street Sludge Disposal Plant, New Haven, Conn. Filling driven pile shells with standard portland cement concrete would have meant holding up nearby drilling until concrete could stand vibration. But—by using Atlas High-Early concrete—piles could be driven close by *the next day!* This saved 10 days on a 20-day job, and $200 on curing costs. Consulting Engineer, George B. Gascoigne, N. Y.; Acting Director, W. Vincent Barry, Dept. of Public Works, New Haven; Contractor, New Haven Road Construction Co., Inc.

NR-E-11

ATLAS HIGH-EARLY CEMENT

A UNIVERSAL ATLAS PRODUCT

ENGINEERING NEWS-RECORD

NEWS

Volume 124 MARCH 28, 1940 Number 13

Roads Instead of Crossing Work Urged in New York

Governor Lehman of New York has suggested to the legislature that the state curtail future grade crossing elimination projects and instead use for highways and parkways $60,000,000 of grade crossing bonds against which no commitments have been made. The Governor believes that much more progress in safety would be possible by using the money for highways than by eliminating grade crossings on railway branch lines which might be abandoned in the course of years.

Since a state constitutional amendment would be necessary, no immediate change is expected.

• • •

Kansas City Bond Fund Diversion Revealed

More than $4,000,000 of the Ten-Year-Plan bond funds was spent by the city administration of Kansas City Mo., without knowledge of the Kansas City Citizens' Bond Advisory Committee, according to a report made by the committee last week. In addition, a total of $7,740,000 of the funds expended up to April, 1939, went for projects unauthorized by the voters of Kansas City, the committee further revealed in telling of funds spent for public improvements under the Pendergast administration.

A total of $47,890,000 of work is involved. Of the expenditures, PWA supplied $3,189,000; WPA, $14,136,000; CWA, $1,197,000; FERA, $573,000, and the Missouri State Highway Department, $3,113,000. The committee in making its report called attention to the fact that $26,340,000, or about 55 per cent of the total spent went for labor. It was also made known that almost half of the bonds voted for parks and playgrounds went for unauthorized projects—only ten of the 28 approved projects ever being started—while 23 projects not in the bond program have been completed.

Sewage Works Organization Plan Endorsed at New Jersey Meeting

Large attendance and successful manufacturers' exhibit at local sewage works meeting helps to launch plan for formation of a national association. Federation convention in October

Sherman Photo

William Orchard, general chairman of the silver anniversary committee of the New Jersey Sewage Works Association, who launched the plan for a national organization of sewage works associations. Orchard, one-time sanitary engineer engaged in state health work, is general manager of the Wallace & Tiernan Co.

The committee, a body without legal standing or funds with which to make an investigation outside the reports handed in by city officials, early last year questioned certain reports and thereupon suggested employment of the consulting firm of Black & Veatch to study expenditures. The report released last week was based on that firm's findings.

An inspired plea for the formation of a strong national organization of sewage works associations made by William J. Orchard, general manager of the Wallace & Tiernan Co., received enthusiastic endorsement from plant operators, consulting engineers, and industrial representatives at the silver anniversary meeting of the New Jersey Sewage Works Association. The meeting, which was held in Trenton on Mar. 20-22, drew nation-wide attention and was attended by official representatives from many state sewage works associations. More than 450 registered for the three-day meeting which counted among its features a sewage disposal equipment exhibit sponsored by 35 manufacturers.

Highlights of the technical session were an analysis of construction trends by Abel Wolman, of Johns Hopkins University and member of the National Resources Planning Board, a review of treatment practice in foreign lands by Frank Bachmann, sanitary sales director of The Dorr Co., a summary of research information on high rate filtration by Max Levine, bacteriologist of the Iowa Engineering Experiment Station, and a report of sewage and industrial waste disposal by F. W. Mohlman, director of laboratories of the Chicago Sanitary District.

Need for organization

Emphasizing the need for an aggressive, adequately financed central organization, which would serve as an instrument to improve the status of plant operators and give national direction to the technical and industrial needs of sewage disposal development, Orchard pointed to the American Water Works

(Continued on next page)

Sewage Works Plan

(Continued from p. 31)

Association as an example of what might be achieved. It was clearly stated, however, that affiliation with an existing organization was not desired or implied.

At the present time, he said, there are 22 sewage works associations in the United States and Canada. Twenty of these are member organizations of the Federation of Sewage Works Associations. The latter, formed in 1928, "was intended to be and is a rather loose federation of separate organizations," totaling some 2,800 members. The activities of the Federation have been very much worthwhile, he stated, but they have lacked coordination and direction.

With proper reorganization and financing, it was pointed out, the Federation would serve as a suitable existing group around which the new organization could be built.

Suggested plan

In brief, the plan put forth involved the creation of an organization in which:

1. Adequate funds would be obtained from membership dues ($5 per year) supplemented with appropriations from manufacturers (regarding the latter, it was suggested that the existing Waterworks Manufacturers Association might extend its support to include the sewage works field).

2. A central office would be established with a salaried executive director and staff in charge.

3. Special emphasis would be placed on the promotion of activity in technical, legislative and personnel affairs.

4. An annual convention would be sponsored to promote exchange of ideas and to permit manufacturers to exhibit their products.

Views of Federation

The official views of the Federation were expressed by Charles A. Emerson, chairman, who said that much thinking had been done on the question of expansion. Therefore, the Federation could readily endorse the desirability of a national organization. It was true, he said, that one of the weaknesses of the Federation is "looseness" in organization, but the purpose of this was to preserve autonomy in local units.

Emerson announced that the Federation was planning to hold its first annual convention in October. The place was not specified, but it was later indicated that it might be in Chicago.

George Anderson, superintendent of the Rockville Center, N. Y., sewage treatment works, said that he would urge support for a national organization in the belief that this would lead to united effort for improving the status of plant operators.

Speaking unofficially, Frank Bachmann, of The Door Co., stated that his company, like many others, undoubtedly would be glad to assist an organization which would provide an opportunity for the display and marketing of its products.

Throughout all of the discussion it was evident that strong support would be given to the centralization movement, provided that this would supplement but not encroach upon privileges now enjoyed by established local units. Early action was anticipated as indicated by a resolution of the New Jersey group empowering its offices to act for or against national affiliation.

Sewage works construction

Backing up his assertions with factual evidence, Wolman said there is no reason to suppose from the past history of construction that there will be any important abatement of such work in the next ten or twenty years. Sufficient backlog in construction necessities, normal increases in population growth, reasonable demand for increased standard of living, more satisfactory budget programming and fiscal practices, should all lead to current improvement and extension in general works construction.

In the field of sewage works construction, said Wolman, several billion dollars worth of potential work is in sight. It should represent something on the order of $200,000,000 or more per year for the next ten years.

Sewage treatment abroad

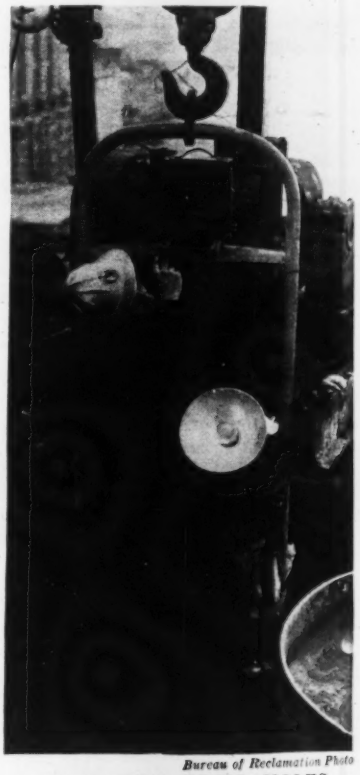
Frank Bachman of The Dorr Company, in describing a recent trip through Europe and India, reported that practically every city in England treats its sewage. One of the special problems of the plants in India is grit removal because it is customary in that country to scour dishes with ashes, and great quantities of the latter find their way into the sewers. In commenting on the number of sewage farms in India, Bachman found small comfort in the fact that the farm vegetables, which were sold to be eaten raw, received only a superficial dipping into permanganate of potash disinfectant before being marketed.

The New Jersey Sewage Works Association elected the following officers: S. R. Probasco, Burlington, president; Henry Van Der Vleit, Maywood, and John Collom, Morgantown, vice-presidents; Paul Molitor, Jr., Morristown, treasurer, and John Downes, Plainfield, secretary.

Engineers Organize For Aid in Emergencies

The Structural Engineers Association of Southern California has set up an organization that will be on call to serve its home territory in case of emergencies resulting from earthquakes, fire, wind storms or tidal waves. According to the announcement, recent adoption of enabling ordinances has made a place for structural engineers to operate under the jurisdiction of the municipal building department in inspecting buildings, condemning them for occupancy or announcing them safe during the trying period that follows any disaster.

Contemplating the help of every member available, the association has been divided into two sections, a staff and an operating section. The first comprises the elements of personnel, intelligence, operations and supply; the second is divided into teams, each under a captain. The staff functions much the same as the staff of a military body, the personnel division as-



Bureau of Reclamation Photo

INSPECTING DRILL HOLES AT GRAND COULEE

A WORKER at Grand Coulee Dam makes the final adjustments of his camera before being lowered for inspecting and photographing 36-in. calyx drill holes at the dam site.

signing and regulating the work, the intelligence division inspecting and reporting conditions to headquarters, and so on. Each team of the operating section has been assigned to a district.

• • •

New Detroit Indictments In Building Inquiry

Indictments numbered 31 at Detroit last week as the federal grand jury investigation of the electrical contracting business in that city continued. The indictments charge that secret pay-offs were made by two Detroit contractors to two union business agents arranging for electricians to engage in slow-downs when working for contractors not parties of the alleged conspiracy.

It was also charged that the defendant electrical contractors established arbitrary, artificial, collusive and noncompetitive bids for electrical work and allocated the contracts among themselves.

The indictments follow a six-month investigation.

Transportation and Power in Connecticut Discussed by Civil Engineers

Railroad concentration centers and local strip airports proposed to improve state's transportation service. Power resources found ample

Improvement of the state highway system, abandonment of unprofitable railroad branch lines and establishment of 15 to 20 concentration stations were proposed by Norris W. Ford, traffic manager of the state Manufacturers Association, Hartford, as a means of improving Connecticut's transportation service, at the annual meeting of the Connecticut Society of Civil Engineers at Hartford last week. As the concentration stations would provide primarily for truck collection and delivery of l.c.l. freight primarily, a better direct-route highway system is needed, Ford said.

Airport development

Development of the state's airports was advocated by Charles L. Morris. To make all parts of the state readily accessible by air he suggested the establishment of 50 or 60 strip fields, which might be as small as 1,800 x 300 ft., to bring every point of the state within 10 mi. of a landing field. At present there are only 18 landing fields in the state, and only six of them can be rated as airports. The four principal ports averaged 1,400 arriving passengers in 1939.

One important item of air facilities now being provided, the speaker said, is a group of ten seaplane bases, comprising simple landing floats by means of which aviators can land for service and communication.

Related transport problems were brought out by Arthur L. Bartlett, maintenance engineer, New York, New Haven & Hartford R.R., and by Homer R. Turner, of the state highway department, Hartford. Bartlett sketched the profound influence of power tools and other mechanical equipment on the speed and cost of track work, from power ballast forks and tamping units to track jacks, rail handling cranes and bridge saws and drills. Trestle maintenance production has increased 40 per cent by aid of mechanical equipment, he said. A large fleet of 3-ton trucks is an essential item of the road's maintenance equipment, and the speaker remarked, "I don't know how we would operate the railroad so far as maintenance-of-way is concerned, without these trucks."

Two stretches of welded track are now in service in the state—a four-track section 800 ft. long at Hartford station, and a two-track section of several thousand feet at Bridgeport.

Highway drainage

Legal questions surrounding the discharge of highway drainage upon private property were reviewed in Turner's paper, which showed that during more than a hundred years statutes have progressively narrowed the right to such discharge. Special drainage difficulties have been caused by the activities of beavers, whose dams at one point threatened to flood a public highway but could not lawfully be interfered with. The difficulty was finally solved by putting a pipe drain through the dam, as the beavers were not able to stop the current through the pipe.

A comprehensive system of road underdrainage is being carried out this

(Continued on p. 34)

Bureau of Reclamation Photo

EXCAVATING 770,000 CU. YD. FOR $9,000,000 FRIANT DAM

EXCAVATION activities are in full swing on the San Joaquin River in California for the Bureau of Reclamation's $9,000,000 Friant Dam of the Central Valley project. The work is being done by the Griffith-Bent Co., Los Angeles, under the direction of Roy B. Williams, Bureau construction engineer of the Friant division.

Excavation in the foreground is for the north abutment. At the top of the picture may be seen a stiffleg derrick erecting a concrete mixing plant near the south abutment. The buildings at the right are part of the general contractor's shops.

Work for the dam includes 770,000 cu. yd. of excavation, stripping 600,000 cu. yd. from gravel deposits, handling 3,200,000 tons of aggregate, and placing 1,907,000 cu. yd. of concrete. Unit prices were published Nov. 16, 1939.

Connecticut Engineers

(Continued from page 33)

year on the basis of successful experience. It comprises a line of bitumen-coated, corrugated, perforated pipe of 8-in. minimum size laid in a stone-filled trench 3½ ft. below subgrade under the uphill shoulder, with clean-outs at angle points, discharging into the nearest water courses.

Power resources

Connecticut power resources, according to Francis T. McNamara, electrical engineer of the Public Utilities Commission, Hartford, are ample to supply peak demand even under maximum wartime production. The state now has 560,000 kw. dependable power capacity (615,600 installed) of which only one-sixth is hydro power. Consumption is almost uniform throughout the day from 8 to 6. Limitations of stream flow, as analyzed by C. W. Mayott, manager of the Connecticut Valley Power Exchange, are such that the hydro stations are of small value in carrying peaks, because of low summer flow and absence of storage; interchange of power with neighboring systems is helpful, however.

Useful information on field practice was brought out in three papers: "Bulkheads," by Arthur G. Beaulieu, of Westcott & Mapes, New Haven; "Maintenance and Repair of Concrete Dams," by H. M. Kopp, Connecticut Light & Power Co., Waterbury, and "Surveying for the Construction of Large Buildings," by E. J. Rockefeller, of C. M. Blair, New Haven. Kopp reported experiences in repairing disintegrated concrete at the Scotland, Tunnel, Bulls Bridge and Stevenson dams with gunite. Results to date are very satisfactory, he indicated, gunite work at Bulls Bridge showing no deterioration after six years' service. At Stevenson Dam, where face guniting is now in progress (see *ENR* Aug. 17, 1939, p. 218) the recession of the concrete face before repairs were begun was 1½ to 2 in. in a single year (1935–36).

Development of the clock-making industry in Connecticut was interestingly reviewed in an address at the Society's annual dinner by Edward Ingraham, president of E. Ingraham Co., Bristol, who traced the beginnings of the industry in the state down through the two centuries.

Frederick P. Stabell, South Norwalk, was elected president of the society, succeeding Charles Rufus Harte. An award for the best paper last year was made to Warren M. Creamer for a paper on the state highway planning survey. William H. Cadwell, Thomas A. Scott and Henry W. Storrs were elected honorary members.

Federal Works Agency Photo

DYNAMITE MAKES WAY FOR NEW WASHINGTON, D. C., BUILDING

ABANDONING the old method of prying and battering a building apart, contractors on the new War Department building in Washington used dynamite to kick the feet out from under a nine-story apartment and let it crumble of its own weight. It was the first time the operation had been tried on a building of anything like this size, and it was completely successful. Four blasts, using 1,000 half-pound sticks of dynamite, converted the building into a pile of rubble and reinforcing steel in a total of 33 hours.

Built in 1925 at a cost of $2,000,000, the building was a reinforced concrete frame structure with brick curtain walls and concrete beam and girder floors; it was irregularly shaped with overall dimensions of 140 x 250 ft. Columns, 16 ft. on centers, were 24 x 30 in., while floor girders were 12 x 18 in. and beams 10 x 14 in.

The building was brought down in four steps, a quarter-section of the building being demolished at a time. It was felt that it would be impossible adequately to inspect the amount of wiring needed to take out the entire building in one shot, and the shock to neighboring buildings might be too great.

As each section was to be shot, three 15-in. deep holes were drilled in each column 2, 3½, and 5 ft. above the base and loaded with dynamite. Effect was thus to blow a 6-ft. section out of the base of each column. There was no other preparation of the building except to knock out interior partitions. Part of the outer curtain wall was removed from the first two sections to be shot, to facilitate rupture of the girders, but this step was found unnecessary and omitted from the last two sections.

Dynamite in the inner columns was provided with instantaneous fuses, while 5-sec. delay fuses were used on the outer columns. The intention was to have the center drop first and pull the outside in on it. The shots were fired with 220-volt current controlled by a knife-switch, since there was too much wiring to use a hand generator.

Demolition was very complete. Except for a section of the roof which rode down more or less intact, there was hardly a piece of concrete on the pile of rubbish more than 15 or 20 ft. long.

Power shovels are experiencing little difficulty in loading the debris onto trucks; skullcrackers on cranes are breaking up the bigger chunks of concrete, and acetylene torches are being used when the tangle of reinforcing bars gets too bad.

John McShain, Inc., Philadelphia and Baltimore, is the contractor on the job. Blasting subcontractor was Murray Shipp, Washington, D. C. Amount of the subcontract has not been made public but is known to have been less than $100,000; this included demolition of four one- and two-story garages.

Few PWA Projects Behind Schedule

Only about 150 projects will be unfinished when the June 30 deadline comes around

Indications now are that when PWA reaches its June 30 deadline, only about 150 projects will be incomplete out of the 6,156 in the 1938 program. This will represent unexpended funds of $35,000,000 or about 5 per cent of the total.

Average overrun of these 150 projects will be about 2 months. Exceptions are the Chicago subway, which will not be finished much before June 1941, the Pennsylvania Turnpike, which has been granted a 6-months extension, the Boston waterworks, running three months over, and the Richmond Marine Terminal, also three months behind.

At present, 5,318 or 86 per cent of the projects have been completed. About 65 per cent of the money in the 1938 program has actually been spent.

Since June, 1933, funds have been alloted for 34,469 projects.

Arizona Engineers Protest Competitive Fee Bidding

Representatives of five consulting engineering firms have protested a call for bids issued by the City of Flagstaff, Ariz., for professional engineering services for a proposed $255,000 water supply project because the bid form called for competition as to the percentage fee to be paid the successful bidder.

Vic H. Housholder, president of the Arizona Section, Am. Soc. C. E., after obtaining a list of the firms invited to bid, called a meeting at which all except out-of-state firms were represented, and then sent a telegram to the city requesting ". . . that such call as set for Mar. 25 be rescinded and that a second call be issued from which would be deleted the competitive fee clause. . . ."

All of the firms invited to bid are headed by members of the Am. Soc. C. E. and in spite of the prohibition against competitive bidding in the Society's code of ethics, it is reported that three of the firms filed bids which have not been withdrawn as yet.

Bureau of Reclamation Photo

CALIFORNIA FLOOD PLAYS ODD TRICK ON VIADUCT FOOTINGS

WHEN the recent flood in the Sacramento River Valley in California (*ENR*, Mar. 7, 1940, p. 343) subsided, engineers were surprised to find on the relocated Southern Pacific around its Shasta Reservoir site a 74-ft. tower supported—not by the four original concrete pedestals—but by two of the footings and a drift log on a third (indicated by the arrow). The viaduct deck had settled 18 in. and moved out of line 12 in. Since the 80-ft. girders at the right and the 70-ft. girders at the left of the tower are not continuous, there has been some speculation as to just how the tower remains standing without the aid of skyhooks. One suggestion is that the bolted-up rails of the track are a major factor in the tower's stability.

Highway Contractors Sign CIO Contracts

Contracts incorporate closed shop and check-off but do not involve engineering employees

CIO's Construction Workers Organizing Committee made its first sortie into the heavy construction field last week with the signature of contracts with three Pennsylvania highway contractors. The contractors are: James J. Skelly Co. of Media, Dalton Brothers, Inc., of Paoli, and Edward R. Sibole, Jr., of Morton. Skelly is president of the Associated Pennsylvania Constructors, but that organization is not involved in the contract. The three contractors, at the peak of the season, employ a total of about a thousand men. CWOC activities hitherto have largely centered on small house construction.

Typical contract signed

The contract, stated to be typical of those CWOC hopes to negotiate in the heavy construction field generally, incorporates the closed shop and the check-off. The contractor, however, may employ any men he wishes provided they join the union. The wage schedule has not been made public, but it is known that rates range from $1.25 per hour for machine operators to 52½ cents for common labor, with most of the skilled rates in the neighborhood of a dollar an hour. The contract provides an 8-hour day and 40-hour week with time and a half for overtime; maintenance work can be done on Sunday at regular time.

Engineers not covered

Engineering employes are not covered by the contract, nor are clerical and supervisory employees.

It is specifically written into the contract that materials may be purchased from any source the contractor desires; CIO spokesmen say this would include non-union materials.

The contractor may assign men to any job, provided that the rate established for that job is paid. However, if a man is shifted to a lower-paid job, he must be given the first opening that occurs in his former classification. The number of men to be employed is left to the discretion of the contractor.

The agreement provides that if the contractor takes work outside his usual area he must pay the rates established in any CWOC contract in effect in that area, or if there is none, the rates to be paid will be adjusted. The union agrees not to give a competing contractor in the same area more favorable terms.

AFL Proposes Lower Wages For Small House Work

A plan for standardization of wages, on a plane from 25 to 40 per cent lower than the present scales, and for equalization of working hours among all crafts engaged in the construction of small houses has been proposed by the AFL building trades department. It would be tried out first in New York City, although similar plans are already said to be in existence in Milwaukee and Philadelphia. A wage of $9 per day for all skilled mechanics and of $4 to $5 for helpers is understood to be contemplated. Present skilled scales vary from $12 to $15, and there is no thought of abandoning these on large building work. In addition to the single lower wage for house workers, the plan provides for a 5-day week of 30 to 35 hr.

Back of the proposal is the fact that 40 to 50 per cent of all building work in the country is in the small house field; that much such work is done by non-union labor or by former union men at rates below the standard scale; that PWA and WPA are releasing union men who will need jobs; that the unions are being accused of keeping construction costs up with their high wage scales; and that the CIO is attempting to break into the small house field with a similar wage and hour proposal, although this reason for the AFL plan is emphatically denied by its leaders.

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ENR Editor Richardson Moves to Chicago

Henceforth headquarters for Harold W. Richardson, associate editor, *Engineering News-Record*, will be in the paper's Chicago office in the McGraw-Hill Building at 520 N. Michigan Ave. There he will be associated with W. W. DeBerard, veteran on *News-Record's* Mid-West front, whose service as western editor began in 1910. Richardson himself is no stranger to the territory that he will now cover, having graduated from the University of Colorado, spent several years as engineer and superintendent with the Bates & Rogers Construction Corp. and traveled extensively throughout the Middle West in the thirteen years since he joined the staff of *Engineering News-Record*. In his new location he will be better able to keep in close contact with contractors' operations, roadbuilding, and engineering developments in the territory from Detroit to Denver and from Canada to the Gulf than he was with headquarters in New York.

• • •

Summer Graduate Institute Planned at Armour

Armour Institute of Technology will conduct a three-term summer graduate institute for engineers, professional men, industrialists and educators in engineering and science starting this year, according to L. E. Grinter, vice-president and dean of the graduate division. The summer institute, which will be divided into seven separate and distinct sections, will consist of three terms of four weeks each. Advanced mechanics, chemical engineering and chemistry, civil and sanitary engineering, electrical engineering and physics, mechanical engineering, industrial engineering, and applied mathematics are the divisions.

Lincoln Electric Co., photo

WELDED ARCH BENT FRAMING FOR ROAD MACHINERY FACTORY

As a part of the program for concentrating all road machinery manufacturing operations at its Aurora, Ill. plant, the Western-Austin Co. has just completed a new factory building of 115,000 sq.ft. notable for its use of arch rigid frame bents as the main units of its completely arc welded frame.

The building consists of three units, a paint shop 75x180 ft., a raw material warehouse 150x250 ft., with three bays 60, 43 and 46 ft. wide; and a product assembly building 120x500 ft. having two bays 40 and 80 ft. wide.

The V-shaped tops of the columns are composed entirely of plate, flame cut to shape and welded. The columns themselves as well as the roof girders are standard rolled sections. The roof, a 20-year pitch and slag type, is carried on a galvanized metal deck with 1½ in. insulating board on top. A feature of the building is the provision for daylighting, the total area of roof skylights being equal to 30 per cent of the floor space. The continuous horizontal runs of sash in the brick side walls also add to the natural illumination.

E. O. Sessions & Co., consulting engineers of Chicago, designed the building and erection was under the personal supervision of J. H. Johnson, chief structural engineer for the designers.

OBITUARY

JAMES C. IRWIN, 71, two years ago president of the American Railway Engineering Association, died Mar. 20 in Newtonville, Mass. Irwin, a graduate of the University of Pennsylvania, began his railroad work with the Wilkes-Barre & Western R. R. in 1888, leaving to go with the Atlantic

JAMES C. IRWIN

Refining Co., Point Breeze, Pa. In 1891 he returned to his alma mater as instructor in civil engineering. This was followed by 17 years with the New York Central & Hudson River R. R. From 1909 to 1912 he served as chief engineer of the Rutland R.R. in Vermont and from 1912 until he retired he was valuation engineer with the Boston & Albany R.R.

THOMAS ADAMS, English architect and authority on town planning and widely known in the United States, died Mar. 24 in Sussex, England, at the age of 68. Adams, director of the Regional Plan of New York from 1923 to 1930, taught community planning at Harvard University.

HERMAN A. WAGNER, who retired from the presidency of the Wisconsin Bridge & Iron Co. a year ago, died in Milwaukee, Mar. 19, the day before he was to be 71 years old. He started work for the firm in 1888, rising through the rank of secretary and general manager.

Other recent deaths include: JAMES B. CLIFFORD, 83, building contractor of Elyria, O.; S. P. MITCHELL, bridge engineer and consultant on the erection of the second Quebec Bridge and consultant on the New York Central R.R. Bridge over the Hudson River at Castleton, Philadelphia, Pa.; JOSEPH A. RUMERY, 79, retired building contractor of New Rochelle, N. Y.; MELVIDORE BRINEY, 68, superintendent of the Rochester, Ind., city sewage disposal plant for the last five years; JOHN C. WARD, 84, civil engineer and from 1881 to 1885 surveyor for Lake County, Ohio, Painesville, Ohio; CHARLES M. SINGISER, contractor and builder of Altoona, Pa.; JOHN Q. WICKHAM, civil engineer of Eau Gallie, Fla., and former city engineer of Melbourne, Fla., St. Augustine, Fla.; EMIL A. BUSACKER, 59, for more than 15 years inspector for the city of Milwaukee bureau of street construction, Milwaukee; CARL A. JOHNSON, 83, pioneer general contractor of Brookings, S. D.; JOHN C. DEVINE, 64, builder of Tucson, Ariz.; EARL C. STANTON, 39, member of the James Stanton Construction Co., Leavenworth, Kan.; EDWARD A. EVANS, 85, Canadian railway and waterworks engineer, Quebec City; ERSKINE W. MCKINLEY, 53, construction engineer employed on the Panama Canal and since 1906 employed at Birmingham, Ala., Hefflin, Ala.; BEN A. SAGE, 70, retired civil engineer, El Paso, Texas; LEE WHITWRIGHT, assistant director of the Akron, Ohio, WPA office, Cleveland; and FRANK KORKESKY, 79, civil engineer and land surveyor, Russelville, Ark.

CONTRACTS AND CAPITAL

ENGINEERING construction awards for the week total $45,018,000, a decline of 14 per cent from last week, and 24 per cent below the volume for the corresponding 1939 week.

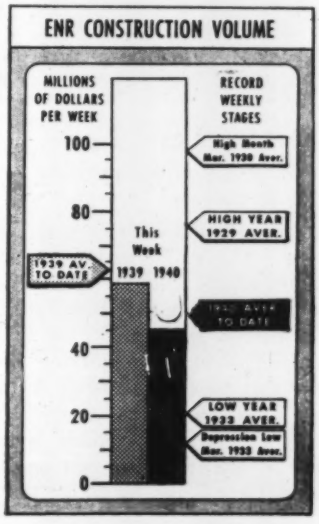
The current week's awards bring the 1940 cumulative total to $642,741,000, a level 20 per cent below the volume for the initial 13-week period last year. Private construction, $215,826,000, is 3 per cent above the period a year ago.

Private awards for the week are 12 per cent lower than a week ago, and 7 per cent below a year ago. Public construction is 15 and 29 per cent lower, respectively, than the preceding week and the 1939 week.

In the classified construction groups, waterworks, bridges, and commercial buildings top their respective volumes of a week ago; and bridges, industrial and commercial buildings, earthwork and drainage, and streets and roads exceed their totals for the 1939 week.

New capital for construction purposes for the week, $11,698,000, is 18 per cent higher than in the corresponding 1939 week. The week's total is made up of $8,225,000 in state and municipal bonds, $3,427,000 in corporate security issues, and $46,000 in RFC loans for public improvements.

New construction financing for the year to date, $238,343,000, is 53 per cent lower than the $505,991,000 reported for the 13-week period last year.



CONTRACTS

(Thousands of dollars)

	Week Ending Mar. 30 1939	Mar. 21 1940	Mar. 28 1940
Federal	$3,850	$10,755	$5,102
State & Municipal	40,117	25,579	25,911
Total public	$43,967	$36,334	$31,013
Total private	15,077	15,868	14,005
TOTALS	$59,044	$52,202	$45,018
Cumulative 1940 (13 weeks)			$642,741
1939 (13 weeks)			$801,102

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial building, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	Cumulative 1939 13 Wks.	1940 13 Wks.
NON-FEDERAL	$232,491	$238,343
Corp. securities	42,132	37,813
State & Mun.	143,623	109,292
R.E.A. loans	21,204	.....
U.S.H.A. loans	25,474	90,547
R.F.C. loans	58	691
FEDERAL	$273,500	$ .....
TOTAL CAPITAL	$505,991	$238,343

FHA MORTGAGES

	Week Ending Mar. 25 1939	Mar. 16 1940	Mar. 23 1940
Selected for appraisal	$26,368	$26,747	$26,167*
Cumulative 1940 (12 weeks)			$239,335*
1939 (12 weeks)			$255,888

* Subject to revision.

ENR INDEX NUMBERS

Index Base = 100		1913	1926
Construction Cost	Mar., '40	238.29	114.55
Building Cost	Mar., '40	201.47	108.91
Volume	Feb., '40	196	86

COMMENT AND DISCUSSION

Readers' opinions on matters that concern the engineer

Vertical Curves

Sir: Your correspondent H. Elliott Brown, so intrinsically tactful of the ingenuity of your readers on the subject of vertical parabolic curves (*ENR*, Sept. 28, p. 393) neglected an opportunity to acquaint younger engineers more fully with a meritorious method for highway or railway grade elevation computation at line sags or summits. I have not seen the method he suggested in printed form, and I wish to submit a general solution, of much flexibility, which I have found to be satisfactory.

Let n represent the number of (100-ft.) stations in the curve of length L. Also, n is to be regarded as any station point number and it is understood that the distances may be expressed in whole and decimal parts of 100-ft. units as desired. The points may or need not be uniformly spaced. Such is a general, though not necessarily a common, case. Successive elevations of points uniformly spaced or selected at random on the curve can be readily found from the computed elevation of the preceding point. As Mr. Brown points out the work is closed-in on the predetermined elevation at P.T., the B end of the curve.

Elevation A, the P. C. end of the curve, equals the elevation of the P.I. (also called the apex of the grades V), minus half the curve length times the per cent of grade. Elevation B is found by adding half the curve length times the per cent of grade through B to the elevation of point V. The slope of the grade is to be indicated by an appropriate sign, and the solution above is an algebraic process.

Assume that the algebraic difference of the intersecting main tangent grades is, in amount, K. An ordinate y_1, 100 ft. from A, is fundamentally equal to K divided by $2n$ (y_1 with regard to sign). r is the product of y_1 and n^2, an independent result for checking grades from main tangent elevations.

To reckon intermediate elevations at any point n in successive order from a preceding point, beginning with the elevations of point A, the procedure is as follows: To the elevation of the preceding point *add* the product of the grade g_1 per cent times the distance therefrom in 100-ft. units to the point sought and *deduct* the product of y_1 times the quantity $[n^2 - (n - d)^2]$; d represents the number of 100-ft. units from point to point. This computation is to be made algebraically. That is, the slope of the grade is to be introduced and considered by the appropriate sign.

Illustrating this rate of change solution for *random* points employing the above successive-step system: $g_1 = -5$ per cent; $g_2 = +7$ per cent; $n=4$ and Elev. of V=150 ft.

$$\text{Elev. A} = 150 - \frac{n}{2} \times (-)5 = 160$$

$$\text{Elev. B} = 150 + \frac{n}{2} \times (+)7 = 164$$

$$y_1 = \frac{K}{2n} = \frac{-12}{8} = -1.50$$

Assume that points whose elevations are sought are separated at distances of 40, 160, 140 and 60 ft., the latter point being coincident with *B*.

Elev. at 40 ft. = 160.00 − 5 × 0.40 + 1.50 × 0.16 = 158.24

Elev. at 200 ft. = 158.24 − 5 × 1.60 + 1.50 × 3.84 = 156.00

Elev. at 340 ft. = 156.00 − 5 × 1.40 + 1.50 × 7.56 = 160.34

Elev. at 400 ft. = 160.34 − 5 × 0.60 + 1.50 × 4.44 = 164.00

Stating the method by formula: Elev. at point n=Elev. of $(n-1) + d \times (\pm)\ g_1 - [n^2 - (n-d)^2] \times (\pm)\ y_1$

M. W. FURR
Professor of Civil Engineering
Kansas State College
Manhattan, Kansas

Checking Level Notes

Sir: In *ENR*, Oct. 12, 1939, p. 79, there appeared an article by Wm. G. Huysman entitled "Checking Level Notes." The writer wishes to submit a more simple form for keeping level notes by omitting the "H. I." column. The method is shown in the accompanying form. The working elevations may be checked as set forth by Mr. Huysman just as easily as the "H. I.'s". At station points between "T. P.'s" the elevations may be easily and quickly found by taking the difference between the last two rod (F.S.) readings and adding this algebraically to the last computed elevation which will give the elevation for the last rod (F.S.) reading. This computation can often be performed during the running of the levels, thus providing a ready reference to any elevations that might be asked for during the procedure.

This method of keeping level notes and checking was used by Chandler & Palmer, consulting engineers, Norwich, Conn., in 1902, at which time I was employed by them as resident engineer on the construction of a sanitary sewer system for the Village of Taftville, Conn.; it was on this work that I became thoroughly convinced of the method's merit. During many years in engineering work I have never contacted this method nor found it shown in any text book.

LEVEL NOTES

Sta.	B.S.	F.S.	Elev.
B.M.	5.82		175.33
T.P.	6.25	2.14	179.01
0+00		4.74	180.52
0+50		6.75	178.51
1+00		3.83	181.43
1+50		4.62	180.64
T.P.		5.31	179.95
	12.07		179.95
	7.45		175.33
	4.62	Check	4.62

A. N. DOUD
Bridge Engineer
East Cleveland, O.

What's an Engineer?

Sir: The very admirable article by Henry W. Taylor, in your Feb. 1 issue, on the subject of "Everybody is an Engineer To-day," is entitled to special attention, appreciation and commendation. It strikes a responsive chord in a lot of us old-timers.

It stirs up thoughts which have long been rankling in the minds of all of us, as to two major propositions: (1) the reckless way the title "engineer" is applied; and (2), the prevalent custom of never giving credit to any individual for any project, announcing only the name of some big corporation as having done the work.

The word "engineer" is the worst abused term in use to-day. I am truly ashamed to answer that I am an engineer, when interrogated as to my occupation, for that always leads to questions as to what railroad I run on, or "Are you a surveyor?" and "Do you make blueprints, and things?" Every laborer who fires a boiler in the basement of an apartment house; every tinkerer who fixes

the plumbing in a hotel; and every chap who ever dragged a chain on a survey (to name only a few) is an ENGINEER! When I answered the question one time at a formal reception where I happened to be in full dress an elegant lady expressed shock and horror, and asked if I really wore overalls and got all greasy! I told her, "Yes, indeed!" My little boys, when the teacher asked them what their daddy did, and they proudly said "He's an engineer," were quite disgusted at her asking what railroad he worked for! The climax came when I found someone putting out cards announcing himself as an "EXTERMINATING ENGINEER", reference being evidently to rats, roaches, et cetera. I thought I knew about exterminating engineers, being one of those almost exterminated by the upheavals and reforms of the past recent years, but as a professional title—that was *too* much!

Regarding the second matter: It would be encouraging and inspiring to the engineer and conducive to efficiency in the project to give credit freely to the engineers in the responsible positions of a project. The habit of changing personnel, often many times, in the course of the development of a project, particularly noticeable on government work, is very bad, for a multitude of reasons. It was not always so. Note the careers of Captain Eads, Roebling, and many others of a generation and more ago.

Let the older engineer vociferously protest these evils!

W. K. PALMER
Consulting Engineer (35 years)
Kansas City, Mo.

Jobs on Old Bridges

Sir: For several years activity in the structural steel field has been much below par. Employment in structural drafting rooms of newly graduated civil engineering students has been far from normal since the beginning of the depression. The railroads, for obvious reasons, have not been in the market for either new work or replacements, and the same appears to be true in the field of highway bridge construction.

An evidence of this condition is found in recent issues of *Engineering News-Record*. In three consecutive weeks, Dec. 7, 14, and 21, 1939, this journal carried illustrations of light and apparently inadequate highway truss spans which had collapsed under excessive loads or by accidental blows by motor vehicles. These bridges were located in Ohio, New Jersey, and Iowa, respectively.

In the issue of January 18, 1940 is shown another such span which may have been saved from a similar fate by having placed upon it a notice reading, "Warning. 10 Tons Safe Load". How extensive throughout the country has been this neglect of proper maintenance in view of the increased demands of present-day traffic? If this source of danger were promptly and efficiently remedied, it would seem that there should result a helpful increase of activity in light highway bridge construction.

FRANCIS P. WITMER
Director, Towne Scientific School
University of Pennsylvania

David A. Molitor

Sir: It seems to the writer that scant justice has been done to the memory of the late David A. Molitor, who died Sept. 8 at the age of 73. For many years Mr. Molitor was a frequent contributor to the technical press. What he wrote was widely read and much quoted.

Sutherland and Bowman in the preface to their "Structural Theory," 1930, state that as far as they know the bar-chain method of elastic weights for the determination of truss deflections is available only in their volume and in Molitor's "Kinetic Theory of Engineering Structures." Further on (p. 61) they give a method, "which promises perhaps the most expeditious solution of the three-hinged arch." The method is that given by Mr. Molitor in the *Engineering News-Record* of April 25, 1929. The same authors, in presenting the Williott-Mohr Diagrams (p. 172), state that it was first brought to the attention of American engineers by David A. Molitor in the *Journal* of the Association of Engineering Societies, June, 1894.

The "Kinetic Theory of Engineering Structures" was published in 1911. The preface is dated, "Ithaca, N. Y., Sept. 9, 1910." Mr. Molitor was then on the teaching staff of Cornell University. The book is well worth study. The present writer knows of no better introduction to the study of statically indeterminate structures than the first three chapters.

Would it not be worth while for some teacher of engineering to write a review and appraisal of Mr. Molitor's contributions to engineering literature?

ROBINS FLEMING
Structural Engineer (Retired)
New York, N. Y.

Schenectady Incinerator

Sir: In the description of the Schenectady incinerator published in *ENR*, Feb. 1, 1940, p. 177, an error was made by the office of the writer in checking capacity figures. In the article the capacity of "each" furnace chamber was stated to be 2,100 cu.ft. However, this capacity is the total capacity for both units and "each" furnace capacity should be stated as 1,050 cu.ft. The same applies that "each" combustion chamber has a volume of 3,100 cu.ft. This relates to the total combustion capacity of the plant. "Each" combustion chamber has a volume of 1,550 cu.ft.

HENRY W. TAYLOR
Consulting Engineer
New York, N. Y.

More Fast Tunneling

Sir: Speaking of tunnel records, the question is always controversial on account of the fact that the size of the tunnel, the conditions of rock and water and the amount of support required are seldom, if ever, mentioned. However, here is one that seems outstanding.

In the Allegheny Mountain Tunnel, being driven for the Pennsylvania Turnpike, an advance of 177 ft. was made in the East heading for the week ending March 1. A total of 1,295 ft. was made in the East and West headings during the 29 days of February, working 20 shifts a week. This tunnel is 32 ft. wide and 24 ft. high, the excavation amounting to 28 cu.yd. per lineal foot of tunnel. Both headings have been continuously supported with 8-in. H-beams spaced on 6½-ft. centers.

The contract with the Pennsylvania Turnpike Commission for this work is held by the Guthrie-Marsch-Peterson Co., Chicago. C. A. Taylor is general superintendent, Carl Neilson, superintendent at the East portal and C. A. Budnik, resident engineer for the commission.

R. M. MERRIMAN
Chief Tunnel Engineer
Pennsylvania Turnpike Commission
Everett, Pa.

ENGINEERING NEWS-RECORD

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MARCH 28, 1940

LANDFILL REFUSE DISPOSAL operations in New York City diminish rather than create health hazards, in the opinion of the committee of eminent public health experts appointed by the Surgeon-General of the United States. This is strong vindication of a method of disposal which has its place in urban sanitation. Granted that landfill disposal has limitations—as do all methods—it nevertheless merited more dispassionate analysis than that which had been accorded to it in public discussions that preceded the experts' report. Comments of critics revealed an amazing amount of prejudice, stupidity and maliciousness concerning New York City's efforts toward better and more economic disposal using landfill. The prime objection, alleged danger to public health and safety, is now declared groundless by experts. Their verdict clears the way for an economical and useful practice and also for the scientific studies which have been instituted by the New York City sanitation department to improve methods of landfill disposal.

A Mistake Repeated

WHEN the American Society of Civil Engineers met in Chattanooga last spring and took the engineering work of the Tennessee Valley Authority as the chief topic of discussion, Arthur E. Morgan, deposed director and chief engineer, was given no place on the program. That unfortunate circumstance—unfortunate because there is no defensible reason for letting political discord fall across the pages of our engineering annals—is now preserved for posterity by publication of the Chattanooga papers in the March *Proceedings* of the Am. Soc. C. E., without acknowledging the error. In the list of TVA personnel, given in a foreword, the name of Arthur E. Morgan, chief engineer from 1933 to 1938, does not appear, although the statement is sufficiently detailed to include assistant engineers and superintendents. Mr. Morgan does not require and no doubt does not wish any special pleading in his behalf on this question, but the precedent that is set cannot go unchallenged. Such censorship has no place in our technical societies.

Costly but Valuable

EIGHTY MILLIONS of dollars is a lot of money anywhere, and at this price the projected Battery Tunnel is in the front rank of modern traffic improvements as to cost. About a mile of four-track road from Manhattan to Brooklyn will cost nearly twice as much as the entire 160 miles of the great Pennsylvania Turnpike. But the tunnel's value as a time- and nerve-saving bypass to the city's clogged street system is correspondingly great, though less easily stated in dollars. Of course the tunnel project is a *tour de force*, since a bridge would have given the service at half the cost. But *tour de force* or not, the tunnel will create a traffic facility whose usefulness cannot fairly be rated by probable toll receipts. It is imperative that we hew pathways through the traffic jungle of the modern city. However it is done, the cost is bound to be of huge dimensions. New York's parkway plan and Chicago's superhighway project are but typical of what the near future will demand of every city that expects to redeem itself from the throttling effect of street congestion.

Self-Liquidating Hokum

ONE OF THE FACTORS in the Battery Tunnel project is the plan to have the city parkway authority build the Brooklyn approach—and thereby hangs a tale. The parkway authority has no money except what it can borrow, and so it proposes to pool its several toll structures, including the very successful Henry Hudson Bridge, as joint security for all its debts, present and future. When Henry Hudson Bridge was built it was declared to be subject to tolls only until its construction cost should be repaid, and the public so accepted it. Now the declaration is conveniently forgotten, and the traveling public is left holding the bag. The same thing happened to the voters who approved bonds for building the Holland Tunnel; they too were given to understand that tolls would continue only long enough to pay off the cost. They were not warned that shrewd administrators later would seize on the toll revenues to carry unprofitable investments on other structures. Perhaps official ethics are flexible enough to condone such deceit

when practiced for the presumed advantage of the public. But if so the time may come when voters and investors will look upon all self-liquidating proposals as hokum. That would not be so good.

Out of the Laboratory

THE SEISMOGRAPH is among the latest of the physicist's more delicate tools to be adapted to practical construction uses. Indeed, its widely recorded success as described on a following page makes it difficult to realize that less than ten years ago seismography was only a research problem in engineering. Starting in 1933, with no more than the knowledge that the seismograph was a used means of geophysicists for exploring deep earth strata, the engineers of the Public Roads Administration undertook its development for subsoil determination at depths that concerned the road-builder and the foundation engineer. A portable instrument for field use was desired and in two years one had been developed and proved by tests. In five years more, through extensive use on dam foundations by the Corps of Engineers and the Bureau of Reclamation, refinements in operation have produced an everyday working device that any engineer versed in physics can operate. Thus, again, laboratory processes are transferred to the field.

Streets Are Still Streets

THROUGH ROADS in congested areas are a new order in city street improvement. Commonly the increase in street capacity has been sought by adding width to thin out the traffic without much consideration for its different destinations. In the Pittsburgh plan of improving Water St., described in this issue, widening, however, is supplemented by intensive segregation of traffic; a complete freeway for through travel avoids all local traffic interference while local traffic is served by separate routes in each direction. The fundamental principle of this plan is that the original traffic function of the street is nowise changed; as always, Water St. will carry every variety of traffic to all its original destinations. In this respect it stands a little apart from recent superhighways for congested areas. Observance of the principle that a business street is a general traffic service facility and is not lightly to be preempted by intruding special-travel routes is of vital significance. Streets are still streets, and in recognizing this fact the planners of the new Water St. in Pittsburgh have adhered to sound engineering principles.

Air Terminals and Fields

SUCCESS IN OPERATION confirms the excellence of plan of the great municipal airport for New York City described in this issue by the man responsible more than any other individual for its creation. An unusually central and flexible site enabled the port to be so laid out that all foreseeable traffic conditions are prepared for; the resultant terminal is likely to be a model for other large airports, as it has already been for that at Washington.

Continuous heavy traffic at the new port draws attention to current demands for comprehensive modernization of air service facilities. If air transport is to play its predestined part we need to have both trunk-line terminals and local landing fields in proper number and distribution. The importance of trunk-line terminals is recognized in the Regional Plan Association's current proposal that an additional major port be provided in the New York region, making four in all—a combined land and seaplane port at Secaucus, N. J., in addition to Newark, Floyd Bennett and La Guardia fields. The demands of local traffic are reflected in a suggestion made to the Connecticut Society of Civil Engineers last week by C. L. Morris, state commissioner of aeronautics, who advocated a number of closely-spaced local strip fields so distributed that one of them is within ten miles of any point in the state.

Granted that both these proposals look toward the future rather than to the present, they are amply justified by the rapid growth of air traffic. Acquisition of the necessary sites in advance is especially important. But before realization of plans can progress farther, the financial problem of building and maintaining the ports and fields will have to be solved. Operating revenues are unlikely to cover their cost, at least for some time in the future. Public support by subsidy will be necessary during the development years. But municipal financing alone is a questionable dependence; even New York's terminal port would show large deficits but for the fact that the federal government through WPA paid for half its cost.

A comprehensive airway system has federal and state as well as local interest, and like other activities of joint concern has a logical claim to joint support. Such support provided through a federal-aid plan under local operating responsibility would effectively prepare for the time when the service pays its way, as ultimately it must if it is to survive.

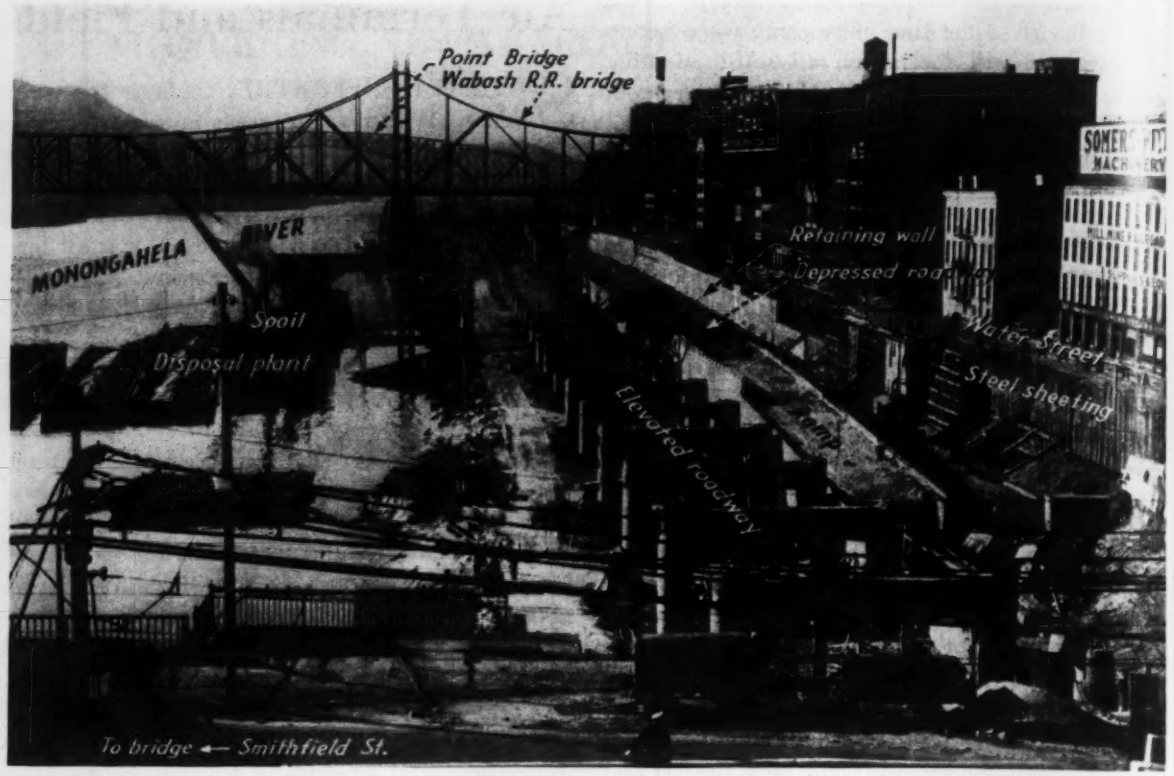

FIG. I. SURFACE, DEPRESSED AND ELEVATED ROADWAYS CONVERT PITTSBURGH'S WATER ST. INTO A TEN-LANE ROAD.

Remodeled Street Triples Traffic Room

Contents in Brief—Planned belt line road for Pittsburgh's business district is started by reconstructing old Water St. to carry ten lanes of traffic. Parallel surface, depressed and elevated roadways involve interesting wall structure and a viaduct which is designed to resist deck uplift from floods.

PITTSBURGH, Pa., is busy with one of the most elaborate of recent street reconstruction operations. Along Water St. active construction is marking the first step of the Steel City to relieve traffic congestion in its famous Golden Triangle. A surface highway, a depressed highway and an elevated highway, with all the structural characteristics of each type of structure, are being built side by side facing a new wharf area for about 3,000 ft. along the Monongahela River. At a cost of $2,500,000 an old 35-ft. street is being replaced by highway structures capable of carrying ten lanes of vehicles.

A glance at the small map, Fig. 2, shows the section of Pittsburgh concerned in the new improvement. Where the Allegheny and the Monongahela rivers converge at a sharp angle to form the Ohio River is the triangular area called the "Point." Entering this district from across the rivers is the traffic from ten street and three railway bridges besides the traffic from that part of the city between the rivers east of the point district. The "Point" then is a focus of traffic lines. To thin out and bypass this traffic the city planning commission has planned a belt highway about as indicated by Fig. 2. The present Water St. improvement is one side of this triangular belt highway. It is being financed by commissioner's bonds and a PWA grant of 45 per cent.

As indicated by Fig. 2 Water St. parallels the Monongahela River to the south. On the north side it is bordered by blocks of costly business buildings, as indicated by Fig. 1. On the building side there originally was a 12-ft. sidewalk and then a 35-ft. roadway from the south edge of which a paved ramp sloped down to the river on a grade of 20 to 25 per cent. The plan of improvement, described in detail later, is to retain Water St. at about the original profile and dimensions and then toward the river to parallel it with a depressed road and then an elevated road. The construction in cross-section is shown by Fig. 4. As indicated the new roadways pre-empt for their location a strip of the original ramp wharf.

The plan is indicated further by the location plat and sections of Fig. 3. Original Water St. and the elevated roadway, which has about the same elevation and profile as Water St., provide for local traffic; Water St. has three lanes for westbound traffic and the elevated roadway has three lanes for eastbound traffic. The depressed road between is for through traffic and has four lanes for traffic in both directions. With the elevated road on the river side a larger part of the original wharf area is preserved for wharf and parking service.

Main structural features

The general plan as shown by Figs. 3 and 4 requires the construction of a retaining wall to support the south side of the westbound roadway and to form the north face of the depressed highway for through traffic. This line of wall is designated as line *A*. Forming the south face of the depressed highway on line *B* are the north sidewalls of the tied walls of the ramp, the footings of which also support the south curb of the depressed highway. The south sidewalls of the tied walls of the ramp and the concrete columns supporting the north side of the outer or eastbound roadway are located on line *C*. The concrete columns supporting the south side of the outer or eastbound roadway are located on line *D*. These columns are spaced 54 ft. longitudinally.

The superstructure for the outer or eastbound roadway consists of two lines of steel girders with curved bottom flanges, spaced 35¼ ft., which in turn support built-up floorbeams and wide-flange rolled steel stringers. The floor deck is a 4½-in. concrete-filled steel grid, except at street intersections and for the portions of the east and west ends of the eastbound roadway where, due to the warping of the roadway surface, the floor consists of reinforced concrete slabs supported on steel stringers. Along the south side of the outer or eastbound roadway, there is a reinforced concrete sidewalk slab 8 ft. wide. The concrete fascias of the structure will support a light, but rigid malleable iron handrailing.

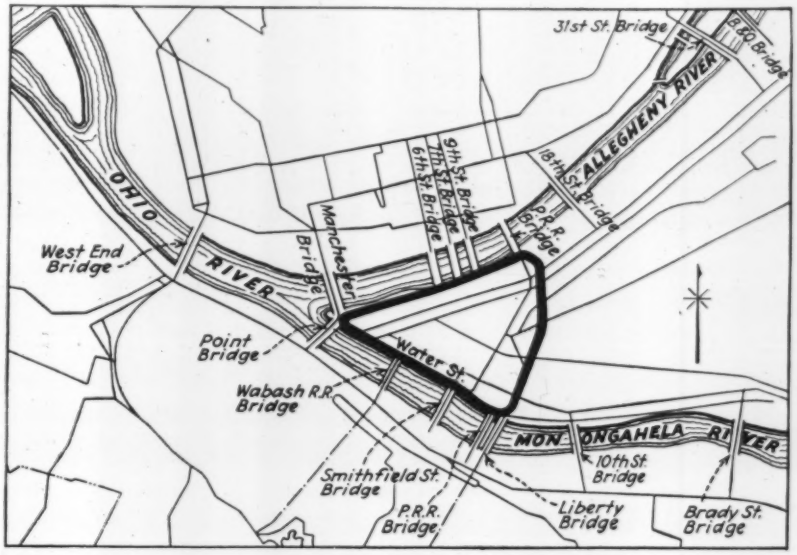

Fig. 2. Location map of belt line planned to reduce traffic congestion in the Point district of Pittsburgh.

Auxiliary concrete curbs are provided along the curbs as an added protection for pedestrian and vehicular traffic. Provision has been made for pedestrians to reach the wharf by stairways at Ferry, Wood and Smithfield streets (Fig. 3).

Design of structures

The walls on line *A* are of variable height with a maximum height of 30 ft. and are of cantilever type. The walls are poured in 27-ft. lengths and are set on a sand or a sand and gravel foundation. The joints between sections of walls are designed with formed keys and with watertight copper seals to connect the sec-

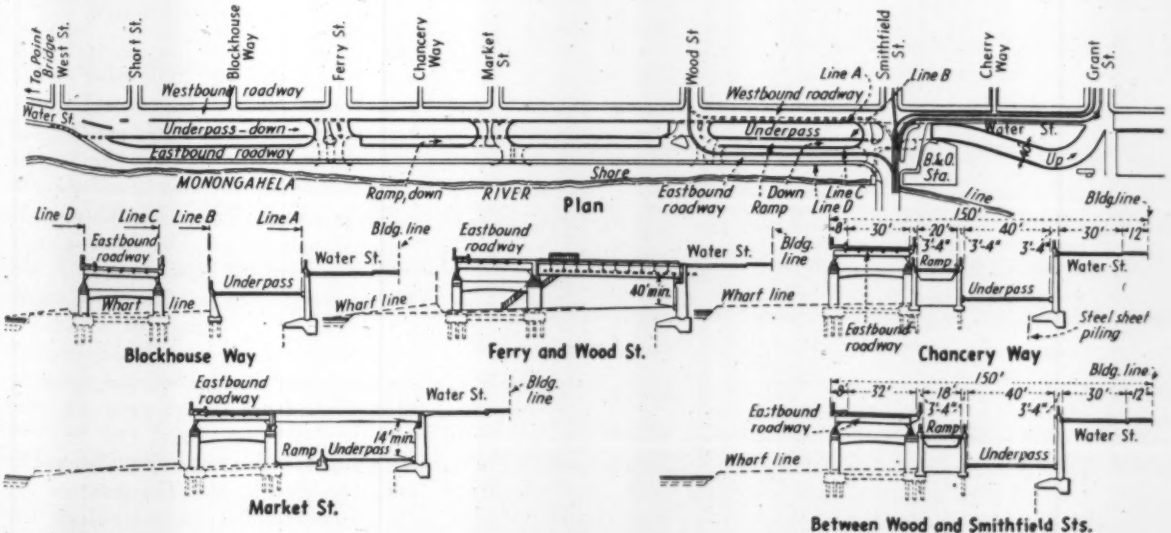

Fig. 3. Plan and sections show provisions for interchanging east and westbound local traffic, ramp access roads to wharf and depressed freeway for through traffic.

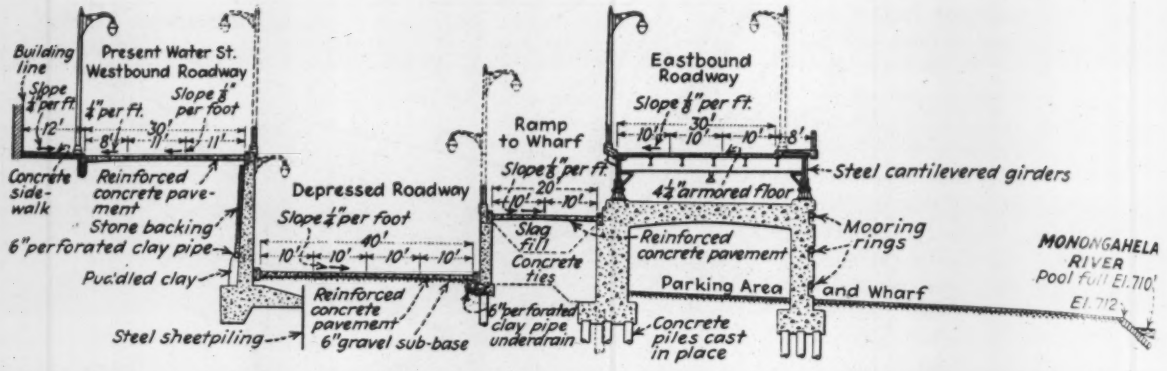

Fig. 4. Main structural elements and trafficways of new Water St. part of proposed belt road in Pittsburgh.

tions, and are filled with premolded expansion joint filler. The abutments at street intersections are designed similar to the retaining walls on line *A*. The maximum soil pressure at the toe of the wall, produced by all superimposed loads, is 2½ tons per sq.ft. To confine the materials forming the foundation of the wall, a continuous line of steel sheetpiling 12 ft. long, extending 5 ft. below the elevation of the bottom of the specially formed heel, is driven and left in place. This sheetpiling and the specially formed heel are also factors in making the wall safe against sliding.

The footings of the tied walls for the ramps on lines *B* and *C* are set on concrete piles, cast in place. At certain locations on line *B* to retain the earth at the south side of the depressed highway, retaining walls of a design similar to the wall on line *A* are provided.

The reinforced concrete columns on lines *C* and *D* which are to support the superstructure for the outer or eastbound roadway are 4½ ft. in diameter and are set on concrete mats which in turn are supported on cast-in-place concrete piles. The piles are driven to develop a supporting power of 30 tons, calculated in accordance with the *Engineering News* formula, modified to take into consideration the ratio of the weight of the ram to the weight of the pile casing plus the weight of the mandrel. The average length of the piles is 25 ft. Each pile is reinforced with a cage consisting of four ⅝-in. round longitudinal bars with ¼-in. round hoops 12 in. on centers securely fastened to the longitudinal bars. The columns on lines *C* and *D* vary in height from 15 ft. to 25 ft. above the top of the concrete mat.

Certain of the columns on line *D* are designed to resist a lateral pull of 40,000 lb. from barges assumed to be fastened to mooring rings cast in the bodies of the column shafts, Figs. 5. The tops of each pair of columns on lines *C* and *D* respectively are tied together with transverse concrete members; thus each pair of columns and the transverse strut practically constitute a rigid frame, Fig. 5.

An extensive study was made of various types of superstructure for the outer or eastbound roadway. The primary reason for the selection of the present design is that it is determinate, easy to erect, of pleasing appearance and economical in cost. The special design feature is that the main girders are cantilever units with curved bottom flanges built up of copper-bearing structural steel plates and angles, shop fabricated in lengths of 87 ft. 4 in. The center 54 ft. of the girders constitute the anchor span, and the ends of the girders constitute the cantilever arms of adjacent spans. The cantilever arms support a built-up steel pin-connected center span. The pin connections permit possible angular changes in the structure at these connections. Structural steel expansion dams spaced 216 ft. apart are provided at the ends of suspended spans to provide for expansion of the structure, and at all other ends of suspended spans, construction joints filled with 1 in. of premolded joint filler are provided in the roadway floor. The structure and its component parts are designed to carry numerous utility lines in addition to the dead load and live loads of 18-ton trucks, congestedly loaded, plus impact. Floorbeams, stringers, the armored deck and the reinforced concrete slab are designed to carry 80-ton trailers. The portions of the structure carrying street cars are designed to carry 30-ton street cars and 18-ton vehicles. In addition to the foregoing, the structure is also designed to resist uplift due to high water and to resist possible forces caused by barges becoming lodged under the structure. The possible magnitude of uplift at each shoe has been calculated to be about 150,000 lb. Anchor bolts of adequate size and cast steel yokes for the shoes are provided to resist this uplift. Silicon copper-bearing steel is specified for a few main built-up girders at street intersections on account of the limited depths of girders permitted to provide necessary headroom.

The handrailing on the superstructure is made of cast ornamental malleable iron pickets with a top rail of 4½-in. O.D. carbon copper-bearing steel pipe supported on a 3-in. steel channel and a bottom rail of 3-in. steel channel. The posts are malleable iron.

Pavement design

All pavement on grade is reinforced concrete. The inner or westbound roadway has three lanes, the north lane being 8 ft. wide (for loading and unloading service to adjacent business houses), and the other two lanes being 11 ft. wide for through traffic. The depressed roadway has four lanes, each 10 ft. wide and will accommodate traffic in both directions. Ramps to wharf level between Ferry and Wood streets are for two-way traffic, and have two 10-ft. lanes. The ramp to wharf level between Wood and Smithfield streets is for one-way traffic, and has two 9-ft. lanes. The outer or eastbound roadway is nearly all on structure and has for the most part three 10-ft. lanes.

All pavement except on the elevated

road is 10 in. thick at the edges, and 8 in. thick at longitudinal joints. Expansion joints of ¾-in. cork are placed transversely in the pavement at intervals of 90 ft., with contraction joint plates at 30-ft. intervals between expansion joints. Longitudinal and transverse contraction joints are steel plates with a triangular key pressed out halfway down. Longitudinal joints only are doweled.

Traffic channelizing islands are unique in that they are 8-in. slabs of plain concrete laid on the pavement and held in place by dowels. Bonding with the pavement is prevented by a coating of asphalt paint. If desired, these islands may be removed or reshaped without damage to pavement.

For simplicity of drainage, all pavement is finished with a slope of ¼ in. per foot from one curb to the other. Underpass and ramp pavements slope towards the river, and pavement on the westbound roadway, eastbound roadway, and connecting structures slope towards the north curb line. By this scheme, the necessity of building trunk sewers for storm drainage only was eliminated. The one trunk sewer along the job, located a few feet south of the north curb of the westbound roadway, takes care of sanitary sewage from adjacent buildings, and stormwater from the westbound roadway and connecting structures. Drainage from the eastbound roadway is caught in scuppers properly spaced along its north curb, and carried by downspouts to the wharf, which is to be paved in the near future.

Construction methods

The major items of construction as indicated by the preceding account of plan and structure are excavating, concrete walls, pavement and viaduct piers, and steel viaduct span erection. A number of contracts are involved but a large part ($1,275,268) of the excavation and concrete work is contracted to the John F. Casey Co., Pittsburgh, Pa. All structural steel work including viaduct deck and paving is contracted to the American Bridge Co., Pittsburgh, Pa., for $498,305. The next largest contract for excavation and concrete wall is held by Donatelli & Donatelli, Pittsburgh, Pa., $253,132.

None of the construction involved particularly unusual methods. Ex-

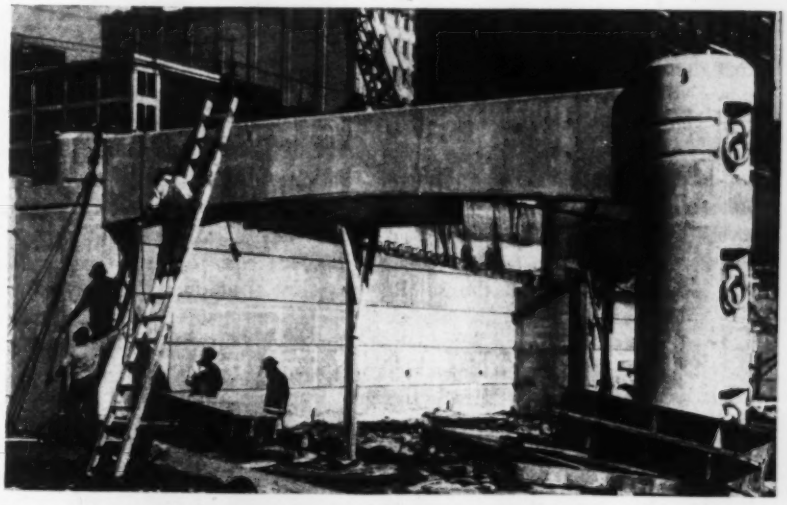

Fig. 5. One of the elevated road's bents shown in Fig. 1; this bent is designed to serve as a mooring post for river craft; back of it is one of the ramp walls.

Fig. 6. Paving on the depressed roadway is done by regular traveling mixers.

Fig. 7. Retaining wall showing method of bracing the steel sheeting behind.

cavation by the John F. Casey Co. is largely with carrying scrapers that dump to the rear. Spoil is disposed of by barges. A barge with four spuds is moored sidewise along shore and the spuds are run down until the barge stands on them. Alongside the fixed barge is moored a spoil barge. The scrapers back up an outshore ramp to and across the standing barge and dump into the spoil barge. Virtually all excavated material is sand, clay and gravel in various combinations, and all is handled as described including truck-hauled material from footings and other small excavations.

For most of the concrete structure the Casey company uses a floating mixing plant. From this plant concrete is pumped to every part of the work. For scattered small work, to which direct pumping is uneconomical, the concrete is pumped to central hoppers that discharge into buckets truck-hauled to the point of placement where they are handled by cranes. An interesting part of the concreting outfit is several small gasoline motor-generator sets to operate electric vibrators. For paving, regular paving mixer equipment is used, Fig. 6.

One interesting detail in the main wall concreting is shown by Fig. 7. To retain Water St. while opening the cut for the depressed road a line of sheetpiling was driven before excavation was begun on a line just back of the rear face of the future retaining wall. Because of the great unsupported height of the sheeting it was braced from the cut side by inclined struts heading against a continuous I-beam wale. The wall was concreted in alternating 30-ft. sections (Fig. 7), the braces in the concreting area being removed and the sheeting across the gaps being carried by the wale acting as a girder between the braces still in place in the cut.

The work as described is being carried out by the Allegheny County Department of Work, John F. Laboon, Director. Robert J. Munce is resident engineer.

Damsite Surveying by Seismograph

ALBERT ELMER WOOD

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Contents in Brief—Seismograph surveys are giving success on flood-control dams. Technique of the process outlined and actual dam foundation survey described. The method is faster and cheaper than drilling and shows remarkable accuracy.

USE OF THE SEISMOGRAPH for foundation exploration is being actively developed by the U. S. Engineer Corps in the extensive program, now under way, of dam building for flood control. The instrument used is the one developed by the Public Roads Administration and described in detail in *Public Roads*, June, 1938, and in *Engineering News-Record*, Aug. 15, 1935. So far the results have been successful and as the process is comparatively new in foundation exploration a brief account of the technique and advantages and limitations, with an example, and the actual determinations, of a dam foundation survey, are given. For greater detail of instrument and technique the articles referred to may be consulted.

Technique of process

The instrument used is small and readily portable; it can be carried by hand through the roughest kind of country and permits investigation in any place that can be reached by foot. It will determine subsurface conditions to any practicable depth, although 150 to 200 ft. is generally the maximum required.

This instrument is of the three-element oscillograph type. A disturbance is set up in the ground by the explosion of a charge of dynamite. The vibrations are picked up by three detectors, placed in a straight line at intervals of 35 or 40 ft. Shots are fired at measured intervals along this line, the nearest being 10 ft. from the center detector, and the line usually extending several hundred feet in each direction. On the nearer shots, the fastest path for the vibrations is a straight line through the ground. On farther shorts, a wave path going down from the shot point to rock, along the rock surface and up to the detectors, is quicker, since velocities in rock are much higher than those in overburden. The relationship of the distance at which the wave through the overburden and the wave through the rock arrive simultaneously to the time required for the vibrations to reach the detector permits the determination of the depth to rock.

The line of shots is extended as far as required to reach rock, a distance normally about three times the depth to rock. The shots are placed in holes 3 ft. deep, usually at intervals of 50 ft. for reconnaissance work, but closer where detailed information of the rock surface is desired; for the last, a 20-ft. interval has given good results.

Field operations require at least three men, but it is better to use a larger crew. For detailed work, it is best to have a survey party locate the shot points and detector stations and obtain the ground elevation at each point. The best results are obtained with a crew consisting of a seismograph operator, a dynamite man and four or five laborers to dig the holes for the charges, fill them after the explosion and transport the equipment from one line to the next. With a crew if this size, the instrument can be operated with the maximum speed and efficiency, and all phases of the work (survey operations, hole digging, shooting and backfilling) proceed at about the same rate. A maximum of four or five lines (70 to 80 shots) can be fired in a full day's work, provided that the shot holes are easy to dig.

The computations of depth to rock

are based on the formulas presented by Ewing, Crary and Rutherford (Geophysical Investigations in the emerged and submerged Atlantic Coastal Plain, Part I., *Bulletin*, Geological Soc. Amer., Vol. 48 (1937), pp. 753–803). These formulas and their derivations are shown by Fig. 1. Although the computations are not difficult to make, considerable practice is necessary in the selection of the correct velocities. The more experienced the computer, the more accurate are the results.

Results at Contoocook Dam

Damsite A is one of several investigated by the army engineers on the Contoocook River in the Merrimack basin. At the dam a glacial deposit blocks the preglacial valley. The Contoocook River has cut a trench along the contact between the glacial fill and the granite bedrock wall. Outcrops are scattered over the right abutment, and several drillholes reached rock at shallow depths. Drilling showed that the rock surface falls off abruptly to the north near the middle of the river, some holes in the valley and on the left abutment going over 100 ft. without reaching rock. Upstream from the center line, on the right abutment, rock also falls off rapidly, raising doubts as to the possible upstream limits for the location of the intake works. The proposed spillway utilizes a saddle about a mile north of the damsite. The typography permits the spillway weir to be placed anywhere in this saddle where rock conditions are the most favorable. The overburden over the entire site, as far as it had been explored, was a uniform fine sand.

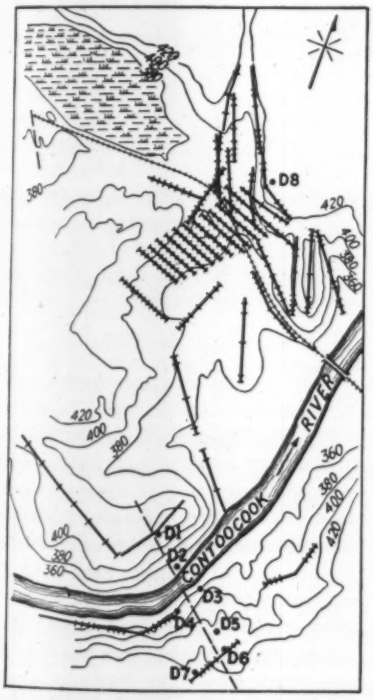
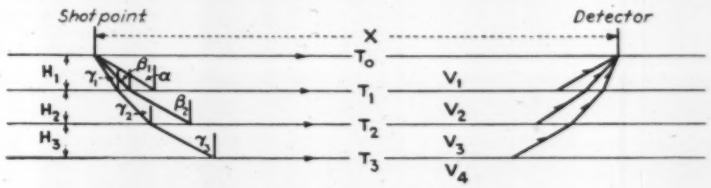


Fig. 2. Map of Damsite A. Lines of seismic shots are shown as heavy lines. Points where the rock elevation was determined by seismograph are shown as crossbars on these lines.



H_1, H_2, H_3 = Thickness of various layers
V_1, V_2, V_3 = Wave velocities in corresponding layers
T_0, T_1, T_2, T_3 = Travel times for paths shown
X = distance between shot point and detector.
$\alpha, \beta, \gamma,$ = angles of refraction

$$\text{Sin } \alpha = \frac{V_1}{V_2}; \quad \text{Sin } \beta_1 = \frac{V_1}{V_3}; \quad \text{Sin } \beta_2 \quad \frac{V_2}{V_3}$$

$$\text{Sin } \gamma_1 = \frac{V_1}{V_4}; \quad \text{Sin } \gamma_2 = \frac{V_2}{V_4}; \quad \text{Sin } \gamma_3 = \frac{V_3}{V_4}$$

$$\text{Then, } T_0 = \frac{X}{V_1}; \quad T_1 = \frac{2H_1}{V_1 \cos \alpha} + \frac{X - 2H_1 \text{ Tan } \alpha}{V_2}$$

$$T_2 = \frac{2H_1}{V_1 \cos \beta_1} + \frac{2H_2}{V_2 \cos \beta_2} + \frac{X - 2H_1 \text{ Tan } \beta_1 - 2H_2 \text{ Tan } \beta_2}{V_3}$$

$$T_3 = \frac{2H_1}{V_1 \cos \gamma_1} + \frac{2H_2}{V_2 \cos \gamma_2} + \frac{2H_3}{V_3 \cos \gamma_3} + \frac{X - 2H_1 \text{ Tan } \gamma_1 - 2H_2 \text{ Tan } \gamma_2 - 2H_3 \text{ Tan } \gamma_3}{V_4}$$

Setting $X = O$ and solving for H_1, H_2 and H_3, gives;

$$H_1 = \frac{T_1 V_1}{2 \cos \alpha}$$

$$H_2 = \frac{T_2 V_2}{2 \cos \beta_2} - \frac{H_1 \cos \beta_1 V_2}{V_1 \cos \beta_2}$$

$$H_3 = \frac{T_3 V_3}{2 \cos \gamma_3} - \frac{H_1 \cos \gamma_1 V_3}{V_1 \cos \gamma_3} - \frac{H_2 \cos \gamma_2 V_3}{V_1 \cos \gamma_3}$$

Since the seismograph measures time in increments of 1/200 sec., a corresponding factor must be introduced into the above equations before they can be used.

Fig. 1. Derivation of formulas used in computing subsoil character from seismograph records.

Several problems had arisen in connection with the design of the dam, which it was desired to solve with the aid of the seismograph, if possible. It was hoped to determine the depth to rock on the right bank of the river at the damsite; the rate at which rock falls off upstream, and the best location of the spillway weir. Several small hills rise in the proposed spillway discharge channel. These were believed to consist entirely of overburden, but a check on this point was desired, since the hills would be removed if rock were not present. There was a conspicuous absence of both fine-grained, impervious materials for the core of the dam and gravel for the shell. It was hoped that the seismograph might help to locate deposits of these materials. The deciding factor in the selection of the seismograph for use was the need for prompt action in obtaining the extensive information necessary to settle these design problems.

Previously, this instrument has been used only as a rapid and economical method of making preliminary investigations. At Damsite A, a detailed seismograph investigation was successfully made, supplementing the drilling program which was concentrated in the embankment area and in the vicinity of the outlet works. Also, several innovations in

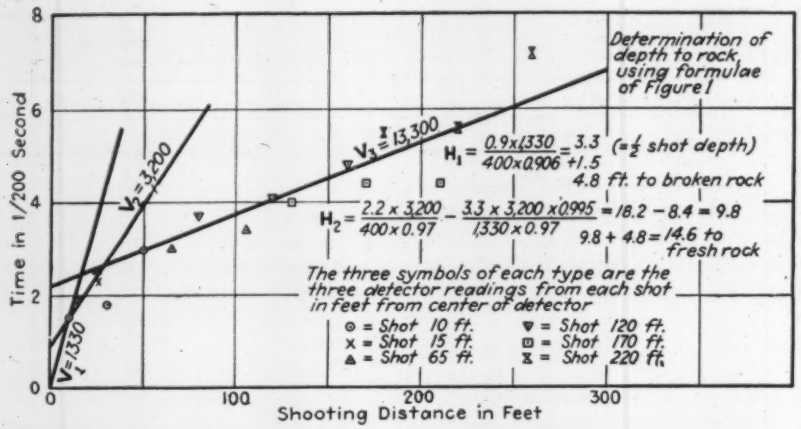

Determination of depth to rock, using formulae of Figure 1
$V_3 = 13,300$
$V_2 = 3,200$
$V_1 = 1330$
$H_1 = \frac{0.9 \times 1330}{400 \times 0.906 + 1.5} = 3.3$ (= ½ shot depth)
4.8 ft. to broken rock
$H_2 = \frac{2.2 \times 3,200}{400 \times 0.97} - \frac{3.3 \times 3,200 \times 0.995}{1330 \times 0.97} = 18.2 - 8.4 = 9.8$
9.8 + 4.8 = 14.6 to fresh rock
The three symbols of each type are the three detector readings from each shot in feet from center of detector
⊙ = Shot 10 ft.
X = Shot 15 ft.
▲ = Shot 65 ft.
▽ = Shot 120 ft.
⊡ = Shot 170 ft.
⧖ = Shot 220 ft.
Time in 1/200 Second
Shooting Distance in Feet
0
2
4
6
8
100
200
300

Fig. 3. **Sample graph of a seismic line, showing the manner in which the records are plotted as a time-distance curve. The computations of depth to rock are shown, using Equations 1 and 2 of Fig. 1. The velocities are determined by the slope of the lines on the graph. V_1 is taken through the origin and the 10-ft. record; V_2 is an average line through the three records of the 15-ft. shot; V_3 is drawn as an average line through the more distant shots.**

the interpretation of seismograph records were made at this site, which proved to be successful, and have been adopted in subsequent work. In parts of the spillway area, the overburden was extremely shallow, and each shot was interpreted separately, so that half a dozen or more depth determinations were possible on each line. Previous seismograph studies had merely determined an average depth to rock for each line of shots. This change in method gave four or five times as many rock elevations as would have resulted from use of the older method. Sufficient rock elevations were obtained in the spillway area to permit the construction of a rock contour map. It is believed that this is the first time that this was ever done on the basis of a seismograph survey. An attempt was made to distinguish between different types of overburden by their velocities, and to determine the nature of these materials. Although this attempt was only partly successful, it gave suggestive results, and laid the foundation for future work along this line.

In the spillway area, nine parallel lines west of the railroad (Fig. 2) showed the rock to be close to the surface, the overburden reaching a maximum of 10 or 15 ft. in thickness. An example of the graph of a line in this area is shown by Fig. 3. This graph indicates one layer of overburden and two layers of rock. The figure also shows the computations by which the depths are determined.

In this region, the seismograph revealed three different layers of rock, characterized by increasing velocity with depth. These zones are not different types of rock, but merely indicate variable amounts of weathering. The uppermost zone was interpreted as being highly weathered, with open joint planes and pockets of overburden. From inspection of road cuts in the neighborhood, it could be seen that more than 50 per cent of the material in this zone was rock. Although it could be excavated only by rock excavation methods, as a whole it reacted to the seismic waves like overburden. Therefore, it is believed to be so highly weathered that it would not make suitable foundations for the concrete structures of the spillway. Below this a zone was found in which the velocities were from 11,000 to 13,000 ft. per sec. This zone is unquestionably continuous bed rock, which would make excellent foundations for structures, but there are joint planes and cracks which are slightly open and along which a certain amount of weathering has taken place, resulting in the formation of thin films of clay. This zone would require a variable amount of grouting. These interpretations are in close agreement with the cores from neighboring drillholes. A third zone was sometimes located, still deeper, in which velocities of about 20,000 ft. per sec. were observed. These velocities are as high as any that are ever attained in the outer shell of the earth, and seem to indicate an exceedingly fresh and solid, massive granite rock. It is believed that this rock would take no grout.

The lines southwest of the railroad showed that the rock surface slopes to the south. The lines east and north of the railroad showed that it slopes to the east, that it is fairly deep along the line of the originally selected spillway, but that it is closer to the surface farther north, lying within a few feet of spillway crest elevation. Accordingly, it was recommended that the spillway weir be moved about 400 ft. north of the originally selected location.

Each line in the spillway area gave from 5 to 15 elevations of the rock. With 30 lines fired in this section, enough elevations were obtained to permit the preparation of a very satisfactory rock contour map. The spillway area was so thoroughly covered that the results may be presumed to have a high order of accuracy, particularly when two or more adjoining lines gave rock elevations agreeing with each other to within a foot or two. With the exception of one line, which was obviously in error, all the results are in close agreement.

The lines fired on the hills in the spillway discharge channel clearly showed that these hills are entirely overburden, and that no rock excavation would be required. Three lines of shots were fired on the terrace forming the left abutment, which show that the overburden averages about 100 ft. thick, but is considerably deeper in places. Of the four lines on the right abutment, two went through drill holes, to check the accuracy of the results. The depths to rock determined by these lines agreed with the records of the drill holes to within a foot. One line, fired along the road upstream from the center line, showed that the rock surface falls off rapidly, being over 200 ft. deep at the upstream end of the line.

Advantages and limitations

The principal advantages of the seismograph are its speed and low cost. At Damsite A, forty lines of shots were fired, which yielded over 350 determinations of the rock elevation. This entire program, including the computation of the results and the preparation of a report, took less than a month's time. The average depth to rock at the points where these determinations were made was about 30 ft. An equivalent drilling program would have taken much longer than a month, even with a considerable number of drill rigs in operation. The cost is likewise much lower for a seismograph survey than for any other

method of obtaining similar information as to rock elevations. Its cost varies from a third to a tenth of that of a comparable drilling program, depending on the average depth to rock and the extensiveness and amount of detail involved in the seismograph work.

Seismic data have been checked against drillholes at a number of damsites. With careful operation and interpretation, the results should always be within 10 per cent of the actual depth to rock. In most instances, they are within 5 per cent of the actual depths, and, in many cases, as when the overburden is uniform, or uniformly variable, the results have checked drilling information within a foot. A seismograph survey is as accurate as is needed for a preliminary investigation, for a consideration of the relative cost of two sites, and for all work where the precise depth to rock at a certain point is not required. A detailed seismograph survey, furnishing data from a large number of points, is proportionately more accurate, checking one line against several others.

This method of exploration does not, of course, tell as much about the overburden as would a drilling program, since no samples are obtained. Work now in progress, however, suggests the possibility of acquiring considerable information as to the nature of the overburden. Experiments are still being carried out to determine the extent and dependability of such information.

One advantage of the seismograph over the drill is that one line of shots can frequently obtain rock elevations at a number of points. Furthermore, the seismograph gives perhaps a more accurate general picture of the depth to which the rock is weathered than could be obtained from a few scattered drillholes, since drillholes rarely discover vertical seams spaced several feet apart, along which weathering usually extends much deeper than in the intervening areas.

It is believed that seismograph explorations may eventually replace a large part of the drilling now required in foundation investigations.

It is desired to acknowledge the assistance and cooperation received from the U. S. Engineer Office, Boston, and particularly from Lt. Col. A. K. B. Lyman, Major L. B. Gallagher, and Reuben Haines of the Soils Laboratory at Concord, N. H.

Manholes by Caisson Method

PRECAST CONCRETE BOXES up to 11 ft. x 4 ft. 2 in. x 6 ft. 6 in. have been installed for manholes and subsurface containers for electrical appliances by setting the box, open top and bottom, over its proposed location, then digging through it with a clamshell bucket permitting the box to sink due to its own weight. The Consolidated Edison Co. of New York, has set more than 165 boxes in this manner since 1938 and it is now a standard method except where there are existing subsurface utility lines which must not be disturbed.

The caisson method has several advantages over the conventional built-in-place procedure, among which are the following:

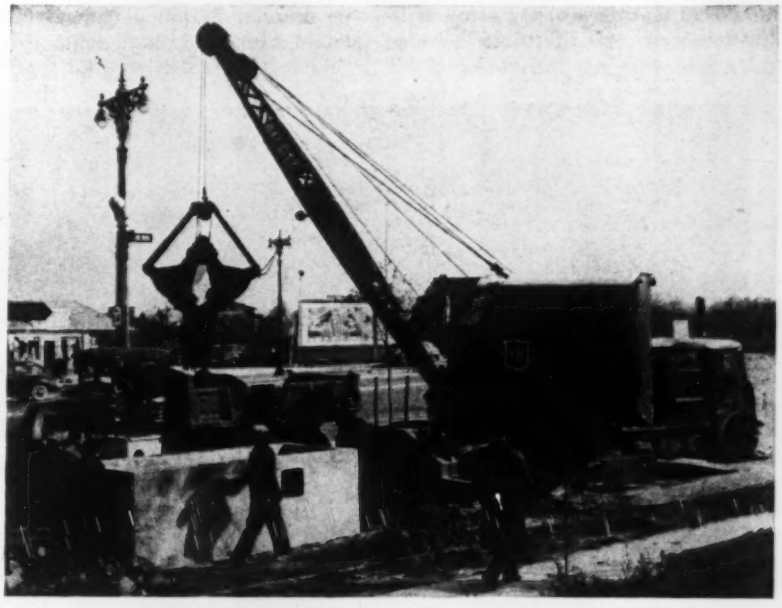
1. Economies of multiple production. Several boxes may be made at one time and stored until needed. Work of different crafts can be completed at the yard with no necessity for taking carpenters, rod-setters, and others to the job for a few hours' work.

2. The caisson manhole walls replace, at no cost, the cofferdam or shoring normally required.

3. Convenience to the public and savings in installation cost since construction formerly requiring five days' work on the street is now done in one day. Inclement weather is not a factor.

4. Safety. Concrete walls prevent cave-ins. Shorter field construction time eliminates traffic accidents.

The four sidewalls of the box are precast in one piece, with desirable knockout blocks provided. The bottom and cover are made separately. When a location for the box has been found free of subsurface utility lines and the pavement, if any, cut open, the concrete box is delivered to the job by trailer. A specially designed heavy duty truck crane sets the box in the prepared shallow cut and is then rigged with clamshell bucket. As the excavation proceeds the box usually settles from its own weight. In some material use of a pneumatic spade is essential for cutting under the sides. When the box is in position the bottom of the pit is leveled and tamped and the precast floor slab lowered into place, bolted and grouted. If desired, heavy equipment, such as transformers, can be immediately set and the prepared cover placed. This completes use of the truck crane which can then travel rapidly to other work, leaving only pavement patching to be done.



Truck crane sets precast box on surface, then digs through open bottom to lower the box. Truck also carries compressor and air tools for supplemental work.

Electric Drive for Ordinary Jobs—III

Motors and Control For Pumps and Compressors

GEORGE H. HALL
Mechanical Engineer, Douglaston, N. Y.

***Contents in Brief**—The load in pumping (or air compressing) varies with the type of pump, being, in greater or less measure, pulsating with reciprocating pumps and uniform with centrifugal pumps. In general terms the forms of motor required are respectively wound rotor and squirrel cage.*

TYPES AND FORMS OF MOTORS, as stated in a previous article (*ENR*, Feb. 29, 1940, p. 326, have been developed for nearly all kinds of construction equipment service. The application of motor equipment is then a problem of selecting the type and form that fit the functional action and the characteristic working loads and speeds of the machine. In general this can be considered to be the obligation of the machine builder but the contractor should be well enough acquainted with good practice to know that it is represented in the machine that he buys. This article describes good practice in motor and control equipment for pumps and air compressors.

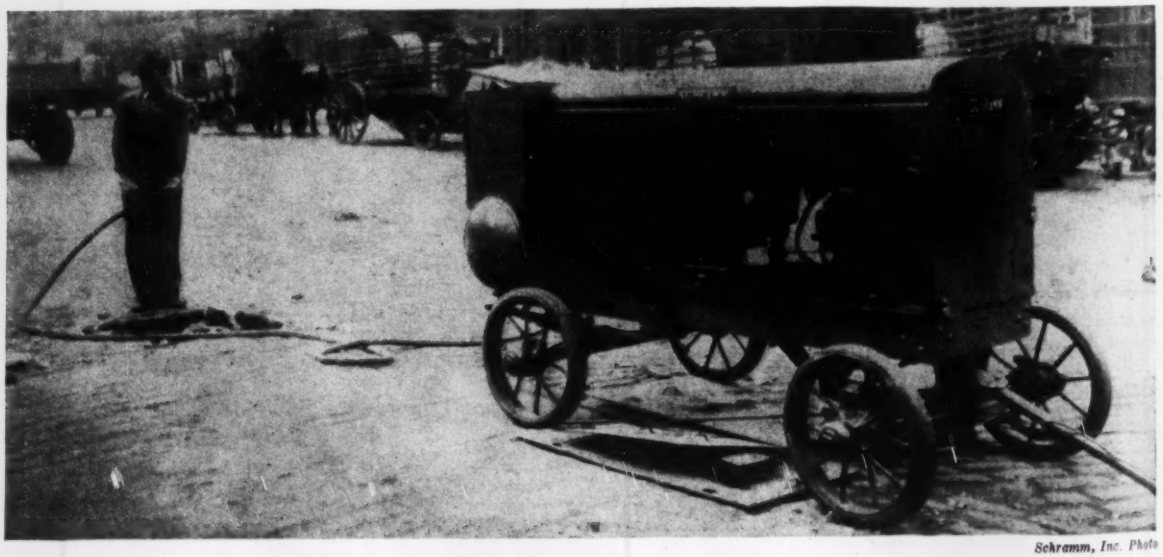
These machines so far as electrification is concerned fall into the same classification; they have the same functional action, are constructed much alike and operate similarly. Motor and power-control requirements are then much the same and are so considered in electrified pump and compressor practice.

For discussion, pumps for water, pumps for concrete and air compressors (pumps for air) are considered separately. The most common use of pumps in construction is for handling water either to remove it from places, as excavations, where it is not wanted or to convey it to operations in which it has to be used. An almost equally common use is for compressing air either for ventilation or for power transmission. Conveying concrete by pumping is a recent development and in the nature of things of less common use. Both rotary and reciprocation types of pumps are used for handling water and compressing air; only reciprocating pumps are used for concrete.

Reciprocating pumps for water

In handling water, construction makes use of both single-cylinder and multiple-cylinder pumps. The first imposes a pulsating load, one pulsation for each stroke, which places an unequal load on the motor. Motors for single-cylinder pumps may be of the squirrel-cage type if the pump is of the double-action type. With single-cylinder, single-action pumps, the pulsations of load are more pronounced and, while squirrel-cage motors will often operate satisfactorily, it is advisable to employ the wound-rotor motor.

With multi-cylinder pumps, say triplex pumps, the triple impulse at each stroke smooths out the load on the motor sufficiently to permit the use of standard constant-speed mo-



Schramm, Inc. Photo

Portable electric compressor used by a public utility company for street opening and pole-setting work.

tors of the general-purpose squirrel-cage type. If the height or lift is great, so that the starting stroke must move a large volume of water in the discharge pipe, it is advisable to employ a motor of the high-starting-torque type. Both types provide for low starting current so that they may, up to 30 or 40 hp, be thrown directly across the line. This application permits pushbutton starting and stopping, thus providing remote control.

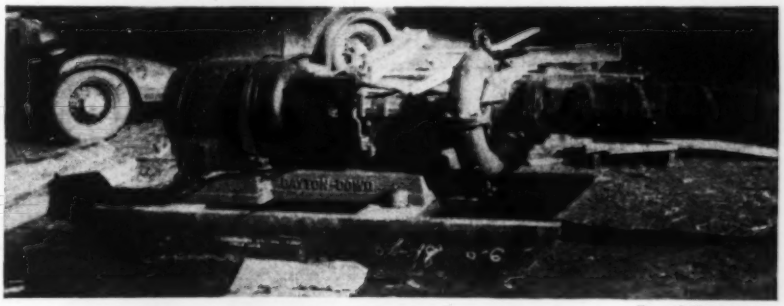
For motors of sizes requiring current-limiting provision for starting, the manual compensator is generally used, which involves local starting, but enables remote stopping by an auxiliary stop button in series with the stop button in the compensator case. Full automatic starting and stopping involves the use of automatic compensators which are much more expensive.

Centrifugal pumps for water

Centrifugal pumps, perhaps the most common pump in construction, are provided with impellers of volute or turbine shape, the latter being used for higher heads and larger capacities than the former. The velocity imparted to the water by the impeller determines the head, or pressure, and this varies with the square of the speed. The quantity of water handled varies directly with the speed. As a result of these two factors, the actual power requirement varies with the cube of the speed. As this may be somewhat difficult for the contractor to estimate, it is advisable to consult with the maker of the pump in selecting the motor equipment in any specific case.

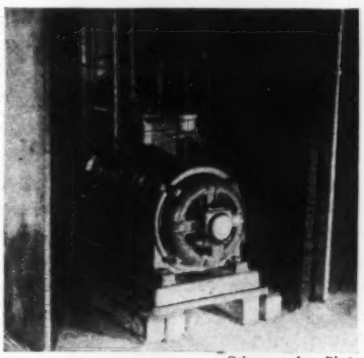
In dewatering, the level of the water is constantly being lowered so that the pump must also be lowered. Direct-connected centrifugal pumps lend themselves most readily to such movement, and they are usually driven by constant-speed, squirrel cage motors.

Centrifugal pumps, running at constant speed, impose a steady and fixed load on the motor and since they start under light load conditions, no provision is needed for excessive starting torque and they may be satisfactorily driven by general-purpose squirrel cage motors up to 50 or 60 hp. For larger capacities, the wound rotor motor allows for gradual acceleration of speed during starting and also provides for speed adjustment. For very large capacities synchronous motors are also used.



General Electric Photo

Small motor-driven pump suitable for such work as dewatering pools of seepage water or small excavations; a 40-hp splash-proof motor is used.



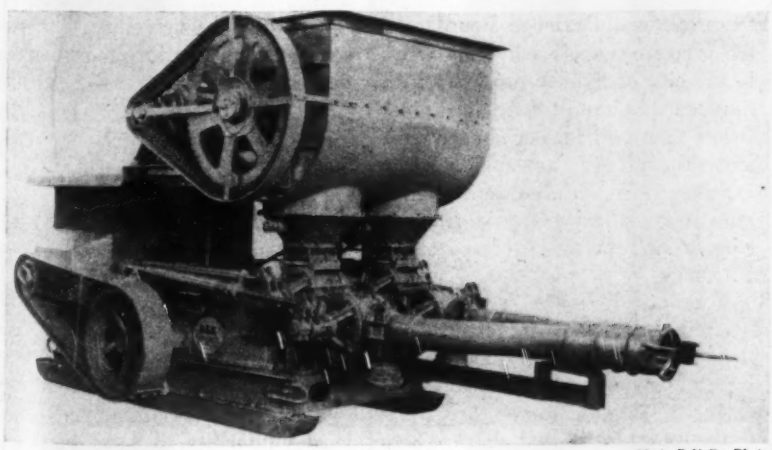
Schramm, Inc. Photo

Portable motor-driven reciprocating compressor designed to be mounted with an air tank on a wood frame.

Pumps for concrete

A novelty in pump power requirements came about with the development of concrete placement by pumping. The concrete pump is a single-acting, single-cylinder water pump, with some modifications to adapt it to its work. The single cylinder is provided with an inlet valve through which mixed concrete from a hopper is admitted into the cylinder during the intake stroke of the piston. At the same time an outlet valve remains closed to prevent any concrete from being drawn back into the cylinder. At the completion of this stroke, the inlet valve closes and the outlet opens so that the forward movement of the piston forces the concrete out into a pipeline by which it is conveyed to the point of application.

As may be seen, the service imposed upon the motor is at a maximum on the forward, or output, stroke and very small on the intake stroke. The wound rotor motor is best suited to meet the demands of such a pulsating load; an adjustable speed is obtained by the use of the wound rotor motor with a control resistance which provides for a number of running speeds below normal. The wound rotor motor is also best suited to the varying load, which at the start with the pipe empty is comparatively light. As soon as the pipe becomes filled with concrete the entire load of pump operation and that of pushing the concrete forward in the pipe imposes the full load on the motor. The motor speed may then be adjusted to meet the demands of this combined load.



Chain Belt Co. Photo

Double-cylinder electrified concrete pump with motor-driven remixing hopper.

The speed control of the wound rotor motor is best accomplished by a drum controller provided with starting and running resistance so that the drum handle may remain on any point at which the motor operates at the desired speed.

Freshly mixed concrete is usually dumped directly from the mixer into the feed hopper of the concrete pump but it has been found desirable in some instances—for low slump or harsh mixtures wherever segregation is likely to occur in charging the hopper—to use a remixing hopper in place of the plain feed hopper. This of course adds to the power load an amount needed for driving the mixing blades and this power is supplied by a separate motor which will be of 5 or 7½ hp. The demand of the remixing hopper being comparatively constant and even, a general-purpose, squirrel cage motor with magnetic starter will adequately fulfill the electrical requirements.

Air compressors

Compressors, like pumps, are made in both reciprocating and centrifugal types. Each of the types has its most favorable field of service, the conditions determining which type is better suited for use in any particular case.

The centrifugal compressor, in the smaller sizes, has the advantage of high-speed operation which permits the use of a smaller and less expensive motor for direct connection than would be required for corresponding horsepower at lower speed. The speed of reciprocating compressors is comparatively low so that some form of speed reducer, either gear or belt, is needed. For direct connection to reciprocating pumps the motor must operate at 900 rpm or lower. The high speed of centrifugal compressors, however, permits the use of motors of 1,800 and even 3,600 rpm for direct connection thus eliminating the need for speed-reducing elements.

For service in what may be termed major projects, such as are met with in the construction of large dams, power houses, important tunnels and sewer work, very large quantities of compressed air are demanded and this is usually supplied by heavy reciprocating compressors which, in mechanical arrangement, are quite similar to compound steam engines. For increasing stages of compression the cylinders may be cross-compounding or tandem-compounded, or a combination of both arrangements may be used.

Motors for the operation of the smaller compressors of both forms are usually of the squirrel cage, low-starting-current type which are started by a magnetic across-the-line starter, or by automatic starting panels in sizes which require current-limiting starting. Since the object of compression in this service is to maintain air pressure in a storage tank, these starting devices are automatically actuated by pressure switches which cause the motor to stop when the maximum tank pressure is attained and to restart the compressor when minimum pressure is reached.

Unloaders are recommended for use in connection with reciprocating compressors operating on alternating current although they may sometimes be omitted when the power service is direct current. The function of the unloader is to relieve the air cylinders of pressure when the motor circuit is opened so that the compressor will have to start only against atmospheric pressure. For operation of the heavy-duty reciprocating compressors which are used on major construction work, direct-connected, synchronous motors are highly recommended because of their constant speed characteristics under varying loads and their ability to keep a high power factor.

In the operation of either pumps or compressors, as they are used in construction work, there is seldom need for an adjustable speed motor but, if such is required, a multispeed, squirrel cage motor, properly chosen for torque characteristics, is preferable to a wound rotor motor.

The next article in this series will discuss motors and power control in concrete mixing.

Australia Regulates House Piping

COPPER PIPING to connect house services with water mains has been required by government regulations in New South Wales, but the report of the Department of Works and Local Government for the year ending with June, 1938, states that the regulations have been amended to permit the use of copper pipe or bitumen-lined pipe of galvanized iron or galvanized mild steel. This change is made as bitumen-lined piping is approved by the Metropolitan Water, Sewerage and Drainage Board, and the pressure tunnels delivering water to the city of Sydney are lined with bitumen. The cost of these lined pipes is less than half that of copper pipe, and although they are slightly more expensive than plain galvanized pipe, they save the heavy expense of recurring repairs to unlined pipe made necessary by internal corrosion.

A proposed change in the regulations to permit the use of 4-in. instead of 6-in. soil pipe was rejected by the government authority after extensive investigation. According to the report mentioned above, where 4-in. pipe has been installed the number of stoppages per annum is much larger than where 6-in. pipe is used. In the city of Melbourne (Victoria) the 4-in. pipe is permitted, but with flush tanks of 2½-gal. capacity, while the 2-gal. tank is standard in New South Wales. It is considered that this extra quantity of water required if the smaller pipes were introduced would increase the water consumption and sewage pumping charges and might contribute to water shortage. With these pipes also, a steeper slope would be necessary, with consequent extra cost for excavation and deeper sewers.

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Road and Rail Tunnels

In improving the alignment of the Swiss Federal Railways near Wallenstadt the old Bommerstein Tunnel is to be replaced by a new one 1,500 ft. long, which is now nearly completed. The old tunnel and its approaches have been purchased from the railway administration by the local authorities to form part of a new highway.

All-Welded Machine Shop Frame Designed for Rapid Erection

S. H. NEWBURN
Air Reduction Sales Co., Pittsburgh

AN ALL-WELDED machine shop building recently completed by the Dravo Corp. at its plant at Neville Island, Pittsburgh, Pa., attracts interest because the members and particularly the roof trusses were detailed to facilitate fabrication and erection by welding, to such extent that punched holes and erection bolts in field connections were almost wholly eliminated. To realize the full advantages and economies of welding, riveted precedent was disregarded. By virtue of the deep welded connections between trusses and columns, analysis of the bents as rigid frames and use of continuity wherever possible, economy in metal was attained.

The shop building is 140 ft. wide by 210 ft. long, comprising a 63-ft. aisle 28 ft. high to the crane rail, and a 76-ft. aisle 37 ft. high to the crane rail; the low aisle contains two 10-ton bridge cranes, the high aisle two 30-ton cranes with 10-ton auxiliary hoists, to serve large machines. A lean-to 20x106 ft. at one end of the building accommodates heat treating, tool dressing, and the like.

In general, the design followed the model set in the frame of a barge assembly shop at the same plant, completed just previous to the design of the machine shop, but details were modified somewhat for fuller adaptation to welding. Columns were made of 24-in., 80-lb. wide flange beams reinforced with channels over the flanges to give increased longitudinal stiffness to the building, in view of the fact that the longitudinal bracing is above the crane girders to provide for future extension. The trusses are wholly of rolled sections, the chords being T-sections made of split I-beams, with angle web members welded directly to the fins. The ends of the trusses, which are haunched to provide greater vertical clearance, are of solid-web plate construction and are stiffened by diagonal, horizontal and vertical bars.

For erection purposes, bar stops, angle cleats, lugs and seat angles were welded to the main members in such way as to permit members to be assembled by the erectors and clamped together while the welder made the connection. Erection in each bay progressed from one end to the other, welding following close behind; the higher bay was begun only after the low bay was fully erected.

Somewhat larger pre-assembled units could be used than would be the case in a field job, as the site was only 100 ft. from the fabricating shop. Nevertheless, the fact that the entire frame was erected complete in 19 working days testifies to the effectiveness of the advance provision for easy and rapid erection.

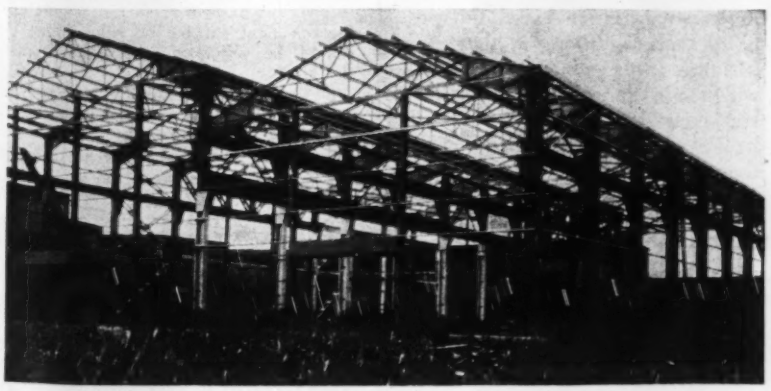

Fig. 1. Machine shop frame completed in 19 working days.

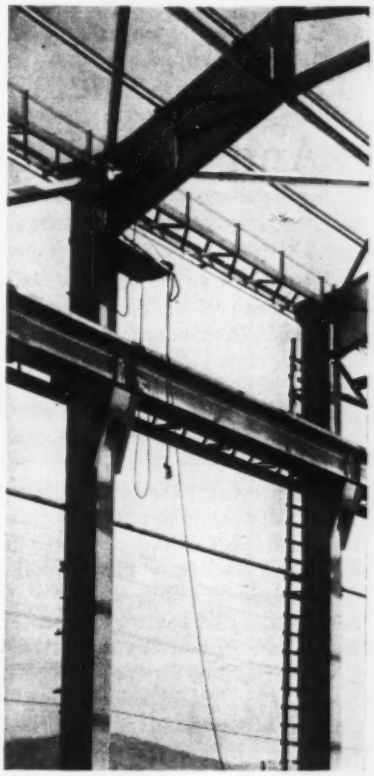

Fig. 2. Welding final end connection of truss to column after seating truss on support angle attached to column flange.

Enclosure of the building is mainly by corrugated asbestos cement siding, in addition to upper and lower belts of windows. Corrugated glass skylights supplement the side lighting. The low aisle has asphalt floor, while the wide aisle has a concrete floor, slabs treated with hardener.

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Chicago Housing Situation

Construction of new residences in Chicago during the past decade has been exceeded by the number of similar buildings demolished on account of obsolescence and the high rate of taxation, according to a report by the Metropolitan Housing Council. Thus, while about 10,300 units were built, or 12,700 including those built by the housing division of the PWA, approximately 20,000 units were pulled down. A trend toward the suburbs is noted in the same report, the reason assigned being that: "Lower taxes, better zoning administration, more effective liquor control, and social conditions apparently have outweighed the advantages of urban life.

Health Experts Endorse Landfills And Recommend Best Practice

DRAWING A SHARP DISTINCTION between refuse disposal dumps and landfills, a board of health experts appointed to study landfill practice in New York City has just reported that these operations do not constitute a hazard to public health or safety now or in the future. On the contrary, says the board, it is convinced that certain potential public health hazards obtaining previously at the sites of these fills have been diminished, for filling is one of the best methods of controlling rats and mosquitoes in marshes and swamps.

The New York City practice (*ENR*, Sept. 1, 1938, p. 270), inaugurated by Sanitation Commissioner William F. Carey late in 1937, became the subject of bitter local controversy and national comment. Finally, the borough of Queens obtained indictments against Commissioner Carey and Health Commissioner John L. Rice charging them with maintaining a public nuisance. An agreement was then reached whereby the indictments were dismissed and the matter was submitted to a board of health authorities for arbitration (*ENR*, June 29, 1939, p. 873).

Members of the board, which was named by Dr. Thomas Parran, Jr., Surgeon General of the United States, are: Dr. M. J. Rosneau, School of Medicine, University of North Carolina; Dr. E. L. Bishop, director of health of the Tennessee Valley Authority; Dr. Huntington Williams, health commissioner of Baltimore; Dr. K. F. Maxcy, professor of epidemiology at Johns Hopkins University, and Ralph E. Tarbett, senior sanitary engineer of the U. S. Public Health Service.

The following extracts are from their report which was made public on Mar. 15.

Disposal of mixed wastes by the sanitary or regulated landfill method, such as used in the areas in question, is not a new procedure. It is known in British practice as controlled tipping. At least two large American cities, namely, San Francisco and Seattle, use it. [See *ENR*, July 6, 1939, p. 59 and Aug. 3, 1939, p. 159 —*Editor.*] It has been the subject of study and, under proper conditions, found to be satisfactory in this country and abroad.

Landfill operations provide for the disposal of total wastes including garbage. They differ from dumps in several important respects. First, the mixed refuse contains a substantial proportion of organic matter subject to decomposition; second, the deposited refuse is concentrated and compacted by the pressure of mechanical equipment; third, it is covered as rapidly as practicable with a layer of earth; and fourth, the operations are conducted under supervision.

Covered by soil, sand or sandy loam, the decomposable organic portions of the refuse undergo oxidation, reduction and disintegration by natural processes. This decomposition goes on rapidly in the first few weeks, reaches a maximum at a time varying with conditions, and then slowly subsides. Consequently during the first few months considerable settlement takes place. Thereafter, the fill tends to become stabilized.

Definition of health hazard

We have given a broad construction to the term "public health or safety." We have studied the health hazards that may either now or in the future arise from the landfills in question. There exists the possibility that conditions at these landfills may favor rats and other rodents which are known to have diseases transmissible to man. On the other hand, many rodents and insects though not vectors of disease may nevertheless be undesirable in the sense that they are detrimental to the enjoyment of well-being. In this same category we have considered the possibility of other environmental influences which may be depressing, such as odors, dust and noise.

From the point of view of safety there are two hazards which need to be weighed. The first is the possibility of fire originating in the combustible material in the fill; and the second the low weight-bearing value of the completed fill for the buildings which may be erected upon it in future years. These possible dangers and others of a lower order of probability have received our careful consideration.

Findings and recommendations

As a result of its observations and studies the board is of the opinion that there are no conditions presently obtaining at the five landfills which endanger the public health or safety. On the contrary, the board is convinced that certain potential public health hazards obtaining previously at the sites of these fills have been diminished, for filling is one of the best methods of controlling rats and mosquitoes in marshes and swamps.

The board makes the following recommendations. In doing so it is not intended to imply that the procedures here recommended are not not being followed in whole or in part.

1. The disposal of wastes by the landfill method should be planned as an engineering project. Operation and maintenance should be under the direction of a sanitary engineer.

2. The face of the working fill should be kept as narrow as is consistent with proper operation of trucks and equipment in order that the area of waste material exposed during the operating day be minimal.

3. The exposed surface should be covered with earth as promptly as is consistent with proper operation and at the close of each day's operation both the surface and the face of the fill should be completely covered, the object being to make a closed cell of each day's deposit.

4. Sufficient standby equipment should be provided to prevent delay in covering, due to breakdowns or peak loads.

5. Waste building material, concrete or other bulky waste material which may furnish rat harborage should not be used for the final surface or side slopes, but should be promptly incorporated within the fill.

6. The final covering for surface and side slopes should be maintained at a depth of approximately 24 in.

7. In case the finished fill has a boundary side slope, the toe of the slope should terminate in a sand and gravel-filled ditch. This will prevent raveling of the toe with exposure of some of the waste material, will prevent the burrowing of rodents, and finally will obviate puddles by permitting seepage from the fill to be absorbed into the ground.

8. Spraying of the exposed waste material and adjacent surfaces should be used when necessary to allay dust.

9. As a rule, the layer of refuse should not exceed an average depth of about

eight feet after compacting. Where deeper fills are necessary the filling should be carried on in stages.

10. Control over the blowing of papers should be adequately maintained by the use of movable snow fencing.

11. While the maintenance of proper earth covering as hereinbefore recommended will to a large extent prevent fires, water under pressure should be available for fire fighting purposes. If scavengers are tolerated they should be adequately supervised.

12. All collections of surface water resulting from these landfill operations should be drained, filled or treated with effective chemicals so as to prevent mosquito production or allay odors.

13. Where necessary, effective steps should be taken to prevent floatage of waste material into open water.

14. Inspection for and control of rodents should be maintained until the fills are stabilized.

15. After the active period of filling operation is completed a maintenance program should be continued until the fill has become stabilized so as to insure prompt repair of cracks, depressions and erosion of the surface and side slopes.

16. Studies of the varied problems involved in landfill operations should be continued and should include researches into the biological, chemical and physical activities, as well as the engineering, economic and administrative aspects.

Unique Framing For Skew Overpass

SAVINGS in the cost of floorbeams by the use of an ingenious framing plan on a sharply skewed overpass were made in a structure recently built by the California division of highways to eliminate a grade crossing on the main line of the Southern Pacific system south of Turlock. With an intersection angle of less than 25 deg. the span length normal to the bents is only 34 ft., compared to an 84-ft. span on the skew along the highway centerline. In the adopted framing scheme advantage was taken of this fact by placing the majority of the main carrying girders normal to the pins. The outer line of girders on each side of the overpass have the full 84-ft. span but these girders are located beneath the sidewalk and hence do not carry as much live load as the others.

Under these conditions, neither the long span girders nor the shorter ones that carry the heavier loads require depths of more than 36 in., the maximum available in rolled beams. Had it been necessary to use greater depths built-up girders would have been required at a considerable loss in economy. Also, greater girder depth would have raised the roadway grade with corresponding increase in grade or length of the approaches. The outer girders were designed and built as continuous beams over the series of supports, thus reducing deflection.

In the deck framing plan as worked out on this structure, there are no expanson joints for about 436 ft. The deck beams are fixed on the center skewed bents, and the framed unit as a whole is supported on rollers on the other bents.

This type of framing, in addition to saving considerable metal in the girders, gives a much more rigid deck structure with minimum deflection under both dead and live loads. It has the disadvantage of making rather indefinite the calculations of exact deflections which ordinarily are made as an aid in striking the surface of the roadway slab. However, careful attention to this detail by experienced construction men, in conference with the designer, resulted in a smooth riding surface.

C. H. Purcell is California state highway engineer, F. W. Panhorst is bridge engineer and L. C. Hollister is senior bridge engineer.

Fig. 2. Floorbeams are set normal to the bents except along outer edges where loading is less.

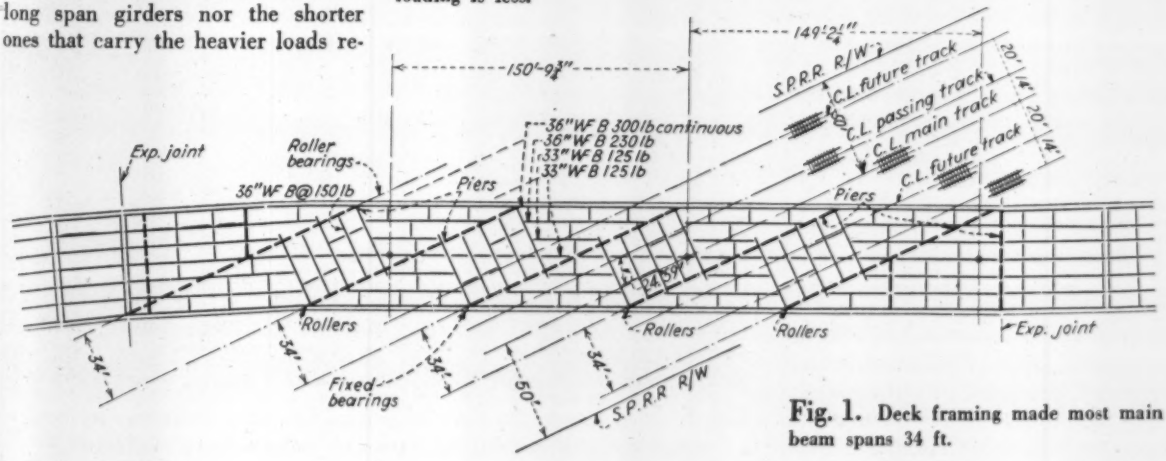


Fig. 1. Deck framing made most main beam spans 34 ft.

Great Lakes Water for Grand Rapids

Contents in Brief — In going 30 miles over a sand terrain to Lake Michigan for its new water supply, Grand Rapids has made wide use of wellpoints in drying trenches and the excavations for principal structures. The project involves the installation of a 46-in. concrete pipeline, two pumping stations, two concrete reservoirs, and a steel pipe intake.

EXTENSIVE USE of wellpoints in the sandy terrain in the vicinity of Grand Rapids, Mich., is one of the outstanding features in the construction of the $4,100,000 Lake Michigan water supply project which that city has under way. The speed in which trenches have been dried up has permitted the laying of a mile of 46-in. pipe per week. And wellpoint header rings on successive berms of a glory hole excavation for a circular well pit completely dewatered the site 31 ft. below lake level.

Elements of the new water supply are as follows: a submerged intake at a point 7 miles south of Grand Haven; an intake line of 54-in. welded steel pipe coated and lined with bitumastic; a circular pumping station substructure and rectangular superstructure; a 46-in. concrete pipeline 30 miles long to connect a lake shore pumping station with the existing filter plant in the city which now obtains its supply from Grand River; a booster station in a loop at the center of the 46-in. line to work in conjunction with the lake shore pumping station to lift the water over the last line of hills near the city; new reinforced concrete reservoirs, one of 8-mg and two of 16-mg capacity on the bluffs on either side of the river; two river crossings, one of which connects the pipeline with the filter plant which is on the east side of the Grand River, and pipelines 12 to 46 in. in diameter in the city which connect the distribution system with the new reservoirs.

Thirty years ago a lake water project was discussed in Grand Rapids, a city of 170,000 population. Allen Hazen made this proposal in 1899. Controversy since 1910 has prevented serious consideration until recently. The possibility of constructing the project without raising rates was made possible through a PWA 45 per cent grant, and the use of storage facilities in the city which permitted a reduction in transmission pipe size from 60-in. to 46-in. A compelling reason for the change of supply is that the Grand River runs from 100 to 300 ppm of hardness, a varying proportion of which is noncarbonate hardness, while the lake at the proposed intake has an average hardness of 125 ppm, practically all in the carbonate form. The project as designed will accommodate a population of 250,000 expected in 1965.

A brief description of the project appeared in *ENR*, June 8, 1939, p. 786; some details of the pipeline fabrication were given in the issue of Jan. 11, 1940, p. 60. The present article describes construction work on the intake line, the Lake Shore pumping station, the long pipeline and the reservoirs. This is of special interest because the work is carried on almost exclusively in dune sand and advantage was taken of this condition to employ wellpoints both at the Lake Shore pumping station and along much of the pipeline, where groundwater is encountered close to the surface.

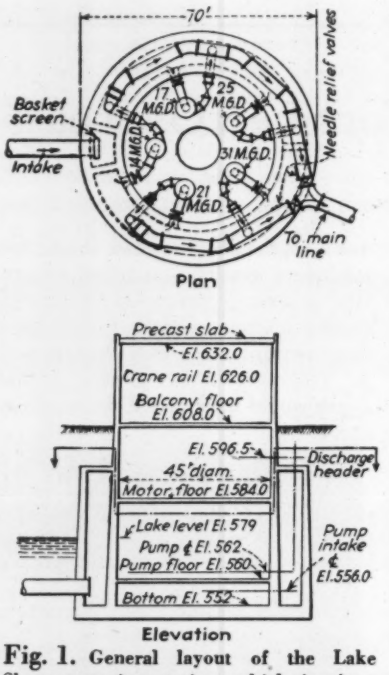


Fig. 1. General layout of the Lake Shore pumping station, which is circular and contains five centrifugal pumps.

Intake line of steel

The 6,000-ft. intake is a 54-in.

Fig. 2. Glory hole for the Lake Shore pumping station, which was excavated with a clamshell bucket after being dried out with wellpoints on two different levels.

welded steel pipeline. It was bulkheaded and floated 13 mi. from Holland to the job in 120-ft. lengths and laid from a submerged wooden crib intake in 50 ft. of water to the circular wetwall of the Lake Shore pumping station.

Before laying the pipe a 10-ft. trench was excavated by suction dredge and a double row of anchor piles driven with four piles at each marine joint. Bents with caps 6 ft. above water were 120 ft. apart. The pipe was lowered by block and tackle attached to the caps after being guided into position by the floating equipment. Divers made up the joints and also placed four 2-in. harness bolts over each Dresser joint to develop the full beam strength of the pipe should unfavorable current excavate or erode the sand under the pipe. The harness bolts of shockproof automobile axle steel (SAE 1035) were placed in lugs welded to the pipe back from the axle joint to give a 3-ft. distance between lugs; experiments were carried out in the shops of the National Tube Co., which furnished the pipe to develop a suitable strengthening of the joint. Nuts on the joint bolts and on the harness bolts placed over $\frac{5}{8}$-in. lead washers were tightened with limited tension wrenches.

A test for watertightness was then made by filling the newly laid pipe and all previously laid pipes with water at 50 to 70-lb. pressure. The tap for the pressure water entered the bulkhead below the center line of the pipe. The air release tap was made near the top of the bulkhead. The pressure compressed the lead washers on the harness bolts of the newly-made joint $\frac{1}{4}$ in. in the time that the test pressure was left on. The cumulative compression at the joints previously laid gave varying amounts (from $\frac{1}{2}$ in. to 2 in.) of increase in distance between harness lugs. The joint safely permits a 5-in. pull. This extra distance was provided for by removing the nuts and threading on an additional lead washer always to permit a contraction of $\frac{1}{2}$ in. for each joint, this to provide for future maximum temperature change from 75 deg. to 45 deg. This precaution was taken to prevent expansion and contraction in the pipeline from opening the joints to the entry of sand as has been experienced elsewhere.

The resident engineer on the intake puts on a diver's suit and keeps definite record of every joint, noting such items as temperature of water, residual space between the lugs for harness bolts and washer crushing. After the line is completely laid every joint will be inspected under water. An inside inspection by an editor of *Engineering News-Record* of the line so far completed disclosed no leakage of water or sand into the line.

The trench in which the pipe was laid extended inshore to permit the scows to lay the line to the pumping station site. Work was discontinued early in December after 2,160 ft. had been laid from the shore close to the first of two emergency intakes which consist of an extension of an upturned tee.

Since the line may not be completed prior to the completion of the rest of the project one of the emergency intakes can supply water before the permanent intake is ready. The latter will consist of a conventional timber crib through the outer walls of which the minimum cross-section of opening will require a velocity of 0.3 fps at the 60-mgd rated capacity and 0.9 fps through the walls of the central cubicle. A 1¼-in. hinged steel cover over a steel grill of $\frac{3}{8}$x2-in. bars on 2-in. centers on top of the central cubicle can be removed in case of emergency to give additional entry of water. It is 7 ft. 9 in. square.

As a preventative measure against frazil ice an 18-in. high-pressure line has been projected to back flush the main line from the new West Side Reservoir, where one high service pump is to be installed.

Two lifts of wellpoints around the 210-ft. circular excavation for the Lake Shore pumping station have been used in lieu of a sheet piling cofferdam. The sand stands up on a 1 to 1 slope. Excavation was carried down about 25 ft. to the lake level at El. 579 and then a header ring with 25-ft. wellpoints was laid on a 2½-ft. berm. These points were spaced along the header every 3 ft. Pumping was carried out for 48 hr. before further excavation was attempted. Then an 18-ft. lift was removed by a crane with a clamshell bucket and the excavated material deposited on the bank; from here the sand was moved farther by dragline and bulldozer.

Fig. 3. Sinking wellpoints prior to opening the trench for the 42-in. pipeline.

Along the second 2½-ft. circular berm another header was placed with wellpoints 16 to 18 ft. long spaced on 2-ft. centers. Pumping was carried on for three days before the water was drawn down sufficiently to permit excavation to be carried down to an 8-ft. layer of consolidated sand. The latter had much the appearance of hardpan, and the top 2 ft. above the finished bottom of the excavation was 31 ft. below lake level.

Pumping the wellpoints continues night and day and has produced a dry hole. Three pumps, one a spare, are provided for each header ring. Valves in the header rings divide them into several sections. Each pump is really performing two functions; in addition to pumping water it also serves to hold a 27-lb. vacuum.

A heavily reinforced concrete foundation slab, 4 ft. thick and 71 ft. in diameter, is designed to withstand

upward pressure. On this base will be erected two concentric walls providing between them a 6½-ft. ring-shaped wetwell with pump in the center.

The annular wetwell is divided so that either half can be unwatered. The pumps in this pumping station are located below lake level and have vertical shafts to motors above lake level. The whole layout is similar on a smaller scale to the high-lift pumping stations of the Los Angeles aqueduct. Discharge pipes from these pumps reenter the annular space, pass upward to a header and then to the pipeline leading to the city. In the wye special entering the flowline are six 8-in. angle relief valves to care for surge.

30-mile concrete pipeline

The 30 miles of 46-in. pipe connecting the Lake Shore pumping station with the city had been about one-half completed when the job was visited during the early part of December. The contractor provided three sets of wellpoint outfits each having 1,000 ft. of header and necessary points; the latter consist of 14 to 16 ft. of 2-in. pipe on top of 3 ft. of perforated screen and the point itself through which the water issues during the jetting operation.

Wellpoints have enough pipe to extend at least 2 ft. below the trench. A typical length is made up of the following dimensions: 1 ft. above ground, 4-ft. minimum cover over the pipe, 4½ ft. of pipe and shell, 1½ to 2 ft. below the bottom of the trench to permit drawdown.

Only 500 ft. of header pipe is connected at any one time, the wellpoints and pipe being carried forward after the pipe has been laid. Pumping draws the water down 2 ft. below the bottom of the trench before excavation starts. No pipe joint is permitted to be made up unless the water is drawn down at least 1 in. below the bottom of the pipe. A hoe type of shovel with ⅝-yd. bucket lays the pipe as well as excavates the trench. The width of trench at the top of the pipe is held to a maximum of 6 ft. Anything over this width must be filled with concrete. The bottom of the trench is hand-trimmed, and after making up the rubber gasket joint, backfilling of the pipe to the springing line is done by hand, two men tamping on each side with a curved tamper. A bulldozer completes the backfilling. Then a length of header pipe with wellpoints is removed and carried forward. The whole operation is worked on a schedule time basis with three different crews operating continuously. The sequence for the

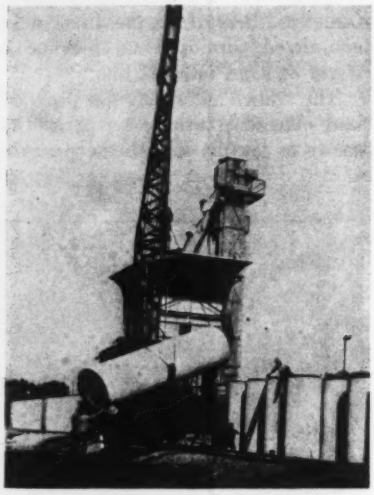


Fig. 4. Moving pipe from the casting yard, where it was made up in 16-ft. sections.

500-ft. length of header requires about 11 hr. when the going is good.

The operation of sinking the wellpoints is simple since it is only necessary to connect the hose on the top of the wellpoint to the pressure header (the suction header with pressure reversed). Pumping and depth of groundwater varies greatly. The water is discharged into a ditch along the highway or into a field where the topography is such as to carry it away. Before the water can percolate down through the sand and return to the trench usually the pipe has been laid and the trench backfilled. There is very little evidence of short circuiting. Gasoline-driven centrifugals are used for pressure and pumping from the wellpoint header.

At the river crossing in town the river bed is entirely in limestone formation with little cover. Sheetpiles were set on top of the rock, and the excavated material, sand, manure and hay, were placed outside of the cofferdam to render it tight. Pipe was then laid in a trench excavated by light powder shots.

Air valves are installed at the summit points of the line and blowoff valves are placed at the low spots. Control chambers are provided with valves which permit closing off portions of the line in case of shutdown for repair. Additional angle relief valves to combat surge are located at strategic points.

The booster station is in a loop along the highway near Allendale, 13 miles from the city, just ahead of the high point of the line. The four pumps at this station, a combination of 14, 21, 25 and 30-mgd electrically-driven units, will work in coordination with those of the Lake Shore pumping station to obtain the highest efficiency at both stations. The capacities of the five Lake Shore units are 14, 17, 21, 25 and 30 mgd and will give a large number of pumping combinations. The maximum capacity required is 55 mgd. Heads will range from 220 to 325 ft. at the Lake Shore station and from 200 to 250 ft. at the booster.

Role of the reservoirs

The reservoirs are of utmost importance in the Grand Rapids project since without these storage facilities a 60-in. line would be needed for the maximum future demand of 64 mgd. With a fill-and-draw program using the 1936 dry period consumption record expanded 50 per cent, reservoir capacity of 3 mgd was needed in the high service and 40 mgd in the low pressure district, together with pumps at the low service reservoirs for pumping into the high service mains. With an 8 and a 16-mgd reservoir already built by WPA, storage will not be drawn below 21 mg in the 5 to 9-day heavy consumption period.

Work is under way on the 16-mg PWA reservoir, some 60 per cent of the contract having been completed in 60 days. Novel in the design is the fact that the reservoir is rectangular with the corners cut off so that the irregular octagon will fit the site. The structure is placed on the site of a former reservoir and is a reinforced concrete basin with flat slab floor and roof. The roof is supported on 80 columns with spiral reinforcing and flared dropheads. The top slab has copper expansion joints between very large units, a maximum of 90 ft. in one direction and 110 ft. in the other. In the joints are 1-in. vertical mastic strips below a fabricated horizontal copper strip which is so made and placed as to give a 1-in. air space above the mastic and below the copper. Asphalt is poured on top of the copper. Not much change in the temperature of the floor or roof is expected when the reservoirs are in

service and after they have been covered with 2 ft. of soil.

Notable in the design of the reservoir is provision for carrying the water from the inlet side of the reservoir along a central dividing wall to the far side in two reinforced concrete conduits which deliver into conduits at the end. The conduits diminish in size as the several outlets are reached. Thus the water must return to the point of entry in order to reach the mains leading to the city. Since these mains are the same in which the water comes to the reservoir, the reservoir simply rides on the line but can be controlled automatically by float-operated cone valves and a telephone dial system operating the same valves.

Formwork

Form panels for the outside walls and the central dividing wall are made up of 5-ply plywood 1 in. thick, 12 ft. wide and the total 22 ft. height of the reservoir walls. A crane moves these forms ahead 2 days after the concrete has been placed. The plywood is backed by vertical 2 x 6-in. studs. The 4 x 4-in. walls 3 ft. apart are secured by clamps.

The concrete mixing outfit consists of two 27-E mixers, one of which is kept in reserve since these are old machines. The mixer is charged by two hopper feeders filled by a crane-operated clamshell from stockpiles near at hand. Distribution is by a pumpcrete machine which delivers to a pipe leading to the point of discharge or to a hopper which feeds into rubber-tired buggies with which the distribution is made.

Personnel

The Grand Rapids waterworks project is being carried out under the general direction of Peter A. Kammeraad, director of public service. Directly under him, handling engineering work is Milo F. Ohr, engineer.

The design of the project was in charge of Arthur W. Consoer and John A. Fulkman for Consoer, Townsend & Quinlan, consulting engineers, with T. H. Wiggin and F. M. Dawson as special consultants. For the consulting engineers Joseph A. Schudt is resident engineer and he is assisted by Keller Wallace, Lester Nelson and William Quinsey. There are 23 other engineering assistants and inspectors on the project.

Contractors for the lake shore and in-lake work are Owens-Ames-Kimball for whom Grant Smith is superintendent. Price Brothers, Dayton, Ohio, are contractors on the pipeline. They are using equipment from the Griffin Well Point Corp., New York City, for whom Harry J. Hush is representative. Emil R. Rutts is superintendent for Pearson Construction Co., Benton Harbor, Mich., contractor for the PWA reservoir. For the pipeline contract in the city and the river crossing, Fry & Kain, Lansing, are contractors with A. H. Fry in direct charge. From Aug. 1 to February the Lock Joint Pipe Co. manufactured 162,000 ft. of concrete pipe in a casting yard in Grand Rapids.

Drafting in the Waterworks Office

SUGGESTIONS for the drafting work on general and detail maps of the underground property of waterworks utilities are included in a report to the American Water Works Association by its committee on distribution system records. Some of these notes are condensed in the following:

Reproducing tracings—When tracings become worn and soiled, it is often cheaper to have reproductions made by photo-lithography than to redraw them. For such reproductions it is advisable to specify that the ink must adhere permanently to the cloth and not crack off. Where it is desirable to keep other records, such as sewer plans, or the master sectional plans for distribution system records, the plans can be prepared showing street, property and lot lines. Then, before adding the waterworks structures these tracings can be reproduced at reasonable cost for use by other departments.

Pantograph—The ordinary wooden pantograph, costing $3 to $6, is a great help in reducing or enlarging subdivision plats, etc., for insertion into the existing maps. It will usually be necessary to bore additional holes in the pantograph sections to obtain proper reduction ratios.

Shadow Box—A shadow or transparency box is a time saver where it is necessary to retrace drawings which are soiled and have little contrast. This is merely a suitably framed piece of heavy glass, and blasted to diffuse lights beneath the glass. A white tin reflector behind the lights is desirable. Two or three daylight-white fluorescent lamps make a fine light source.

Lettering Sets—The use of lettering sets will enable an otherwise mediocre draftsman to produce excellent work. While slightly slower than free hand lettering, the higher quality of work may be worth the extra time. Titles should be made wherever possible with a lettering set.

Rivet Pens—Since many small circles must be drawn to show fire hydrants, the use of a "rivet" pen will be found preferable to the ordinary bow pen.

Adhesive Tape—This recent development, or "Scotch tape," has many uses in the drafting room. It can be used to tack work to the glass surface of a shadow box. It will also hold tracing paper or cloth on maps which thumb tacks would mar. Where it is necessary to place successive dates on tracing cloth originals after they have been corrected, these dates can be inked on transparent tape placed on the tracing. The tape and the inked date can be easily removed, making it unnecessary to ruin the tracing by successive erasures.

Erasing Machine—The small electric erasing machines pay for themselves in speeding up erasures. Their use, along with an erasing shield, will allow extensive erasures to be made with small damage to the tracing cloth.

Washing off Pencil—It is often necessary to remove pencil marks from the inked tracing cloth. This can be done quickly with a soft rag moistened with benzine or cleaners' gasoline. The solvent must evaporate completely without leaving a greasy residue.

Printed Tracing Cloth—Where it is necessary to make a large number of tracings which have a common form the basic information can be printed on the sheets at a cost much below

that of preparing the common forms by hand.

Rubber Stamps—It is often necessary to repeat many words such as scale and sheet number on the numerous drawings. Rubber stamps, with the proper ink, will speed up such routine work.

Pre-Stressed 108-Ft. Girders In German Bridge

THE FIRST USE of pre-stressed steel in an important permanent reinforced concrete bridge structure was recently reported from Germany, according to Guttorm N. Brekke, War Department structural engineer, Washington, D. C.

The bridge, over the express highway between Ruhr and Hanover, has a span of 108 ft. (102 ft. clear) and consists of four girders 4 ft. 9½ in. deep at the ends and 5 ft. 3 in. deep at the center. Both the longitudinal steel and the stirrups are pre-stressed, an expedient that changes the principal tension stresses in the concrete into compression stresses.

An axiom of pre-stressed reinforced concrete is that the pre-stressing of the steel must be so high that the subsequent loss of stress through shrinkage and plastic flow of the concrete constitutes only a portion of the pre-stressing; furthermore that a sufficient portion of the pre-stressing remains to keep the entire concrete cross-section of the beam in compression under all conditions of live load. Although shrinkage and plastic flow stresses may exert as much as 20,000 lb. per sq. in. on the steel, the availability of high strength reinforcing makes it possible to apply a pre-stressing sufficiently high to keep the concrete under proper compression without exceeding the yield point of the steel. A section of one of the five girders used is shown in the accompanying sketch.

In constructing the girders the reinforcement for the lower flange was first placed in the form and pre-stressed through the medium of a wooden beam installed underneath the form and to which, the pre-stressing device was fastened. Concrete was then poured into the form for the lower flange of the beam, vibrated and compacted by inserting a flexible rubber hose which was expanded under high hydraulic pressure. The excessive water in the freshly poured concrete was thereby made to escape through the narrow joints between th individual form elements. To induce rapid hardening the concrete was heated. Upon completion of the lower flange the web and upper flange were poured with their forms in turn.

After sufficient hardening of the concrete the pre-stressing device was released by removing wedges in the middle of the auxiliary wooden beam.

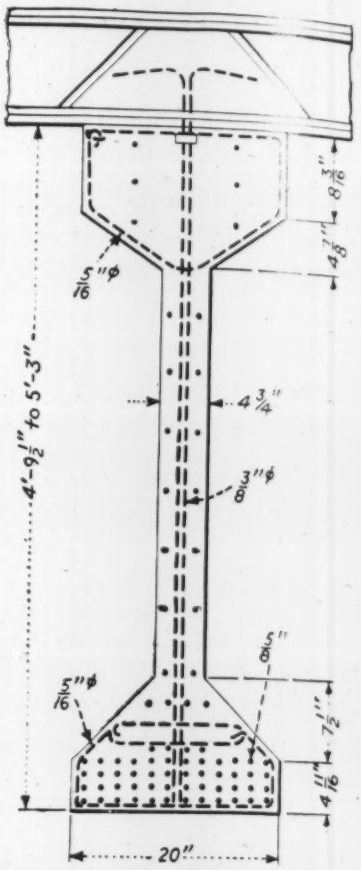


Fig. 2. Section of girder in which both longitudinal steel and stirrup were pre-stressed.

The high tension of the pre-stressed steel thereby was transferred to the hardened concrete thus creating in this a compression to counteract and balance the existing tension in the reinforcing steel.

The girders were fabricated at a rate of one a week on a staging adjacent to the bridge, and were then moved laterally to their position on the abutments.

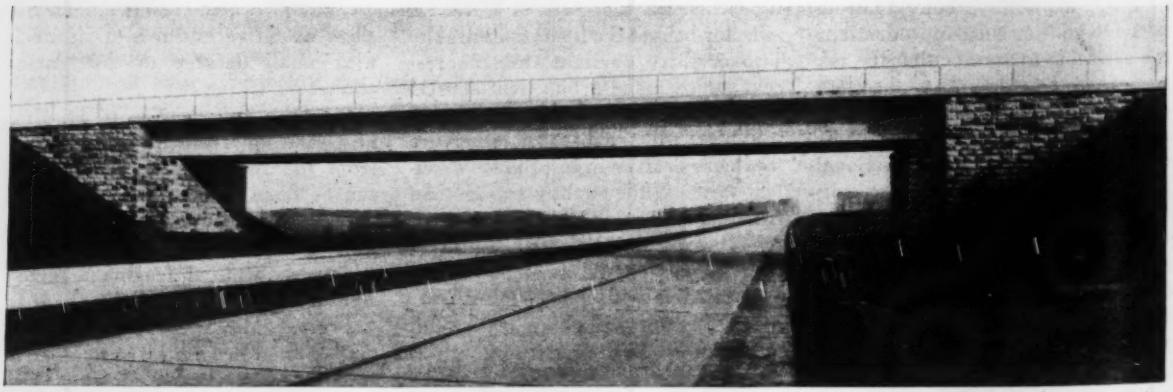
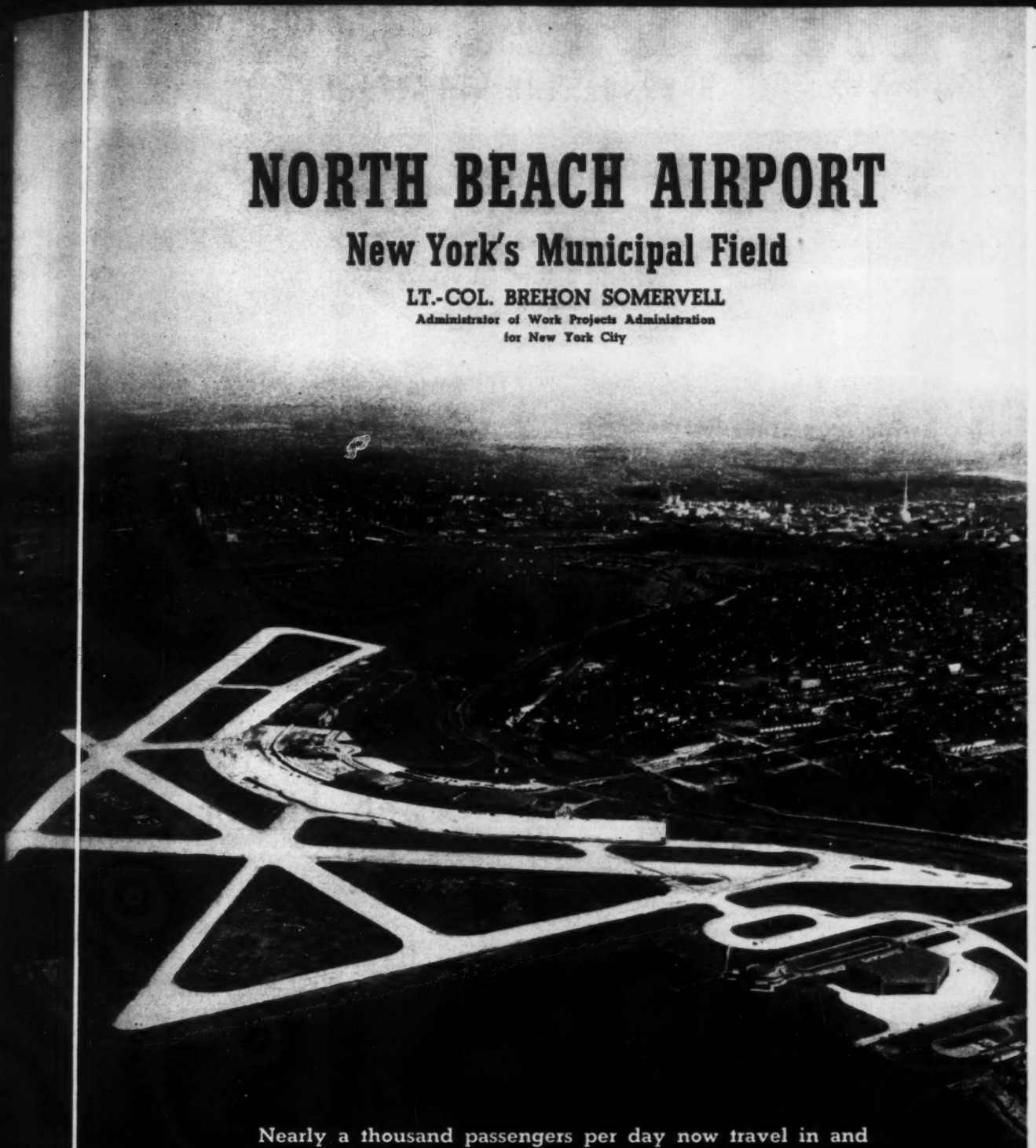


Fig. 1. Concrete girder bridge of 108-ft. span built according to the pre-stressing principle that eliminates all possibility of tension in the concrete.

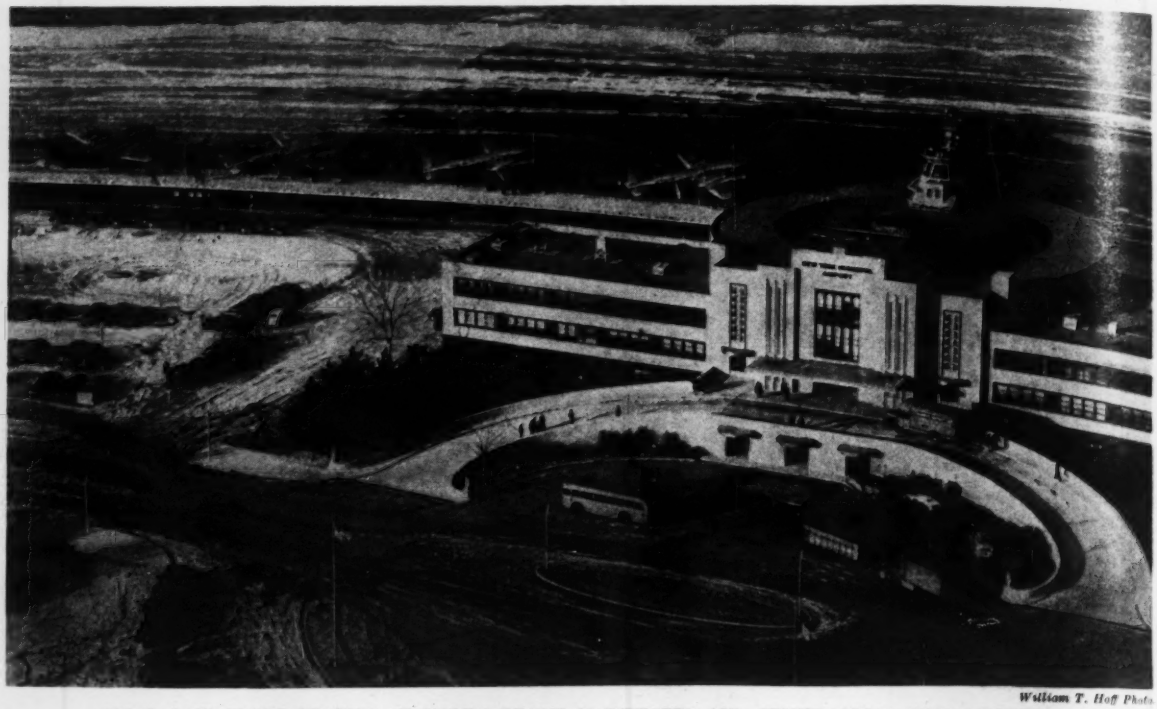
NORTH BEACH AIRPORT

New York's Municipal Field

LT.-COL. BREHON SOMERVELL
Administrator of Work Projects Administration
for New York City



Nearly a thousand passengers per day now travel in and out of New York by way of the newly opened La Guardia Field, largest and most modern airport and the first central air terminal of America's metropolis. Its mile-long runways are laid out to provide for future needs as well as receive present-day large and fast planes. A group of three articles outlines general planning, field layout and structures of the terminal.



William T. Hoff Photo.

FIG. I. LAND-PLANE TRAFFIC AT NORTH BEACH IS DIRECTED AND SERVED FROM THIS BUILDING.

Planning North Beach Airport

LT.-COL. BREHON SOMERVELL
Administrator of Work Projects Administration for New York City

AIRLINES operating into and out of the New York metropolitan region are now using the largest and most modern airport in the United States if not in the world. Representing an expenditure of more than $40,000,000, the New York Municipal Airport (La Guardia Field as it has been officially named) is destined to set standards for major air terminals elsewhere.

Everyone knows that New York is the largest seaport and that the city reached its leading position because of this port. Yet few know that just before the present European war, in 1938, New York had more air passengers than overseas passengers. Half of all the air business in the United States originates in or is destined for New York City, and air traffio from New York to Europe, set back by the war, has just begun to grow. The need for an airport in New York City is unmistakable.

Early in 1937 the Mayor and the Commissioner of Docks suggested the possible construction of an airport to the Administrator of the Work Projects Administration in New York City and asked that the matter be studied with a view to undertaking the work as a WPA project. The site proposed was on Sanford Point, Queens, where the former North Beach-Bowery Bay amusement area had been developed by the Curtiss-Wright Co. as a small landing field. When the plans for the present development were begun the area had been taken over by the city and was being operated as a field for itinerant flyers.

An ideal site

Its area then of 105 acres with three small hangars and a small haul-out ramp for seaplanes restricted its use to local service. But the site was ideal in convenience and accessibility. Central to the metropolitan region, it has excellent land and sea access. It is at the center of a comprehensive network of highways and parkways; all parts of the region, and especially central Manhattan, can be reached in a few minutes (Fig. 1).

From Grand Central Terminal, where much traffic originates and opposite which the airlines are now erecting a $6,000,000 headquarters, the airport may be reached via Triborough Bridge and Grand Central Parkway, via Queensborough Bridge, or via the new Queens-Midtown Tunnel. Brooklyn and downtown Manhattan are quickly reached by the new Meeker Ave. route. The parkway system connects to the east with Long Island and with eastern and southern Queens and Brooklyn. The new Whitestone Bridge leads directly to Westchester and Fairfield counties. The Triborough Bridge offers another approach from the Bronx.

A better location to serve the needs

of air passengers could hardly be wished. Mail transfer also is exceptionally direct (Fig. 3). The airport is 12 min. from the 125th St. station on the New York Central and New Haven main lines, and 12 min. from the Woodside station of the Pennsylvania system.

Finally, in view of the small shipping traffic in the channel between North Beach and Rikers Island just to the north it was possible to develop an adequate seaplane terminal. This fact, combined with the other advantages of the site, convinced the local WPA that the North Beach Airport proposal had unusual merit.

Preliminary planning was begun in the spring of 1937. A rough plan had already been worked out by the city's department of docks, but it was soon apparent that this would have to be modified extensively. A series of consultations with the nation's leading experts then began, to develop various phases of the work. The airport as it stands today is the result.

Consultation with experts

Col. Sumpter Smith, then head of the airways section of the office of the chief engineer of the WPA, was called in and immediately thereafter Capt. L. L. Odell of Pan American Airways. The Bureau of Air Commerce was represented by Capt. William H. Hooker and Clarence Coombs. Actual layout was supervised by S. E. Stott of the WPA in New York City.

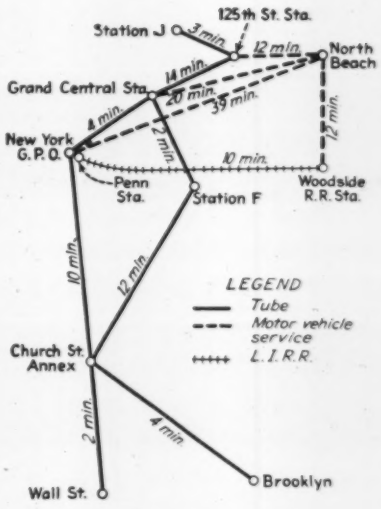


Fig. 3. Efficient mail handling is made possible by pneumatic tube, vehicle and rail connections; note the official mail transfer times.

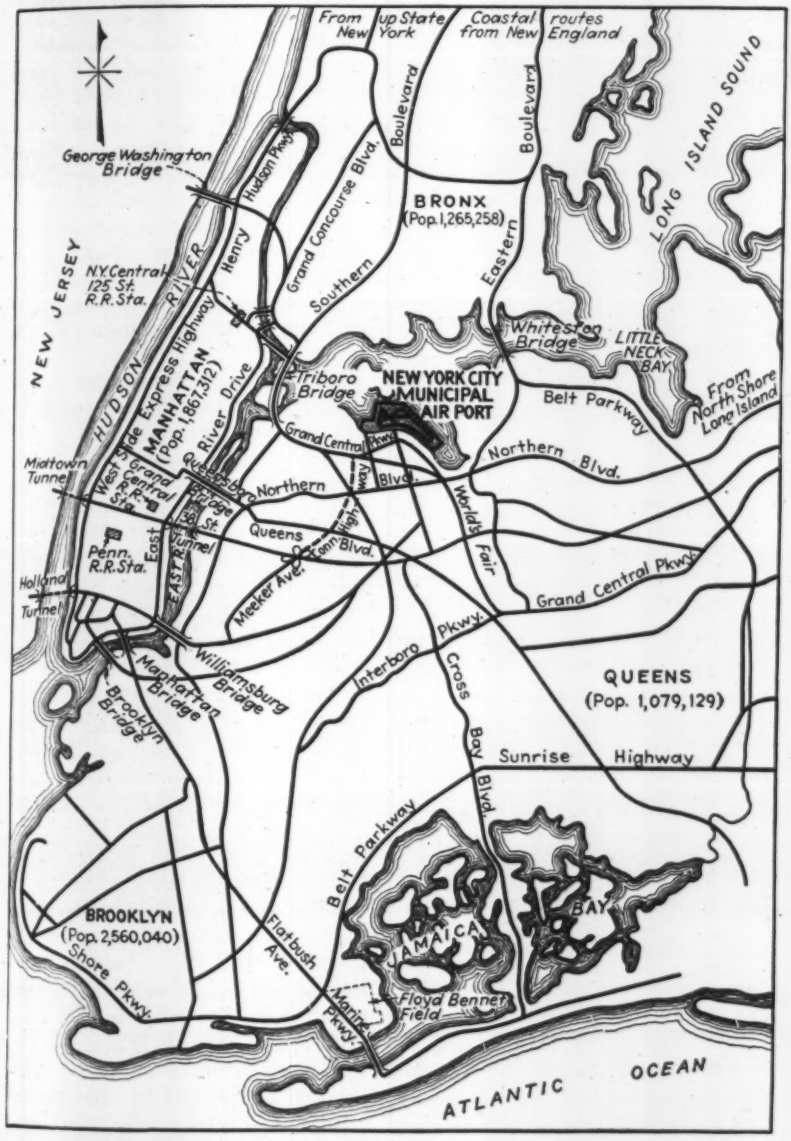


Fig. 2. Main highway routes radiating from LaGuardia Field give it a central position in the New York metropolitan area.

At the outset the planning was complicated by the presence of a boat basin near the center of the proposed development, it is probably fortunate that the boat basin remained, as it removed the buildings a sufficient distance from the parkway to secure good architectural effect. There is also little question that the demands for parking space and the lack of utility of the boat basin and its seaward approach will require a modification of the present layout in due course.

Other phases of the construction indicated the desirability of consultants along other lines. William A. Delano and George Licht of Delano & Aldrich were retained as architectural consultants on the preliminary plans and were later retained by the city for the preparation of the final plans of the buildings and the landscaping. A large part of the work consisted of filling in parts of Flushing and Bowery bays to provide the necessary runways for landplanes and of dredging Bowery Bay to furnish an approach and turning basin for seaplanes. As much of the fill was over a deep layer of soft silt, in places over 80 ft. thick, and as the behavior of the fill, both before and after dredging alongside, was critical to the success of the work, a board of engineers consisting of Walter J. Douglas, Brig. Gen. M. C. Tyler and

William T. Doran was created to study this phase of the work and to make recommendations on the method of placing, retaining, and draining the fill as well as to estimate quantities.

Broad sweep of design

When it became evident that the work was seriously under way and that the airport was to be a reality and not just conversation, real interest was displayed by the airlines. A committee of their experts was formed to assist in making the port provide the maximum in safety, convenience, and economy of operation.

Owing to administrative difficulties, the order for making the building plans was not formally given by the Mayor until the end of the year, so that architectural plans were some months behind the others. Originally drawn with the help of aviation experts to meet what was thought would be the desires of prospective tenants, the plans were changed continually, in some cases radically, as leases were signed and the actual needs of tenants in the land-plane area became known.

The design of a large and important airport is far from what it was when a few acres and a few sheds would suffice. Nor is the work restricted to providing for the aircraft. To be successful the design must permit not only the safe landing and departure of planes, economical and prompt servicing, their control of flight, and complete administration, but also must provide adequate and commodious accommodations for passengers as well as for expeditious and economical handling of mail and express. In addition if, as is the case with La Guardia Field, the airport be a port of entry, provision must be made for the customs, immigration, and public health services.

With various federal and city departments, their architects and engineers and the officials of a number of airlines, involved, with the present lack of crystallization of ideas with respect to the aircraft industry, and with the usual amount of citizen advice, it can be seen that there a major task of coordination was presented.

A final major decision must be made when the broad outlines of the development are determined. This is, "What shall be the character of the construction?" Shall the principle of bare necessities apply or shall the design provide for the maximum in the way of safety and convenience? Shall the structures be commodious and enduring, suitable for expansion in a fast growing industry, handsome and dignified, worthy of the best in architecture and engineering in the city for which they are built? The decision was to build the best.

Laying out the Field

MERE ACRES do not measure the capacity and usefulness of a flying field, especially at a metropolitan central terminal. Natural conditions, layout and structures affect its utility. Factors are topography, force and direction of winds, width, length and character of runways, and the service structures of the field. For what it is worth it may be set down that La Guardia Field comprises 558 acres of land area, that it is irregular in shape (Fig. 4) and is about 2 mi. long by ¾ mi. wide at its broadest point.

It will be noted from the map that the field is divided into two distinct parts, the land base and the marine terminal. The latter embraces not only the land area but also the turning basin and anchorage in Bowery Bay included in the angle formed by the bulkhead and the edge of the fill. Following the wind rose, both land and sea runways are roughly parallel. The approaches to the airport are over water for the most part. To the southwest are low dwellings only, making it possible for ships to lose or gain altitude gradually without fear of meeting obstructions.

A hill 90 ft. high on part of the site and the great extension of the field out into the water to north and east necessitated moving about 17,300,000 cu.yd. of material. Of this, 2,320,000 cu.yd. came from the hill and 14,980,000 cu.yd. from Rikers Island, lying to the north.

Subsurface survey

Subsurface exploration by drilling and soil sampling, carried out by the U. S. Engineer Department, indicated that the foundation material offshore was a very soft, silty clay varying in depth from zero to over 80 ft. and underlaid by sand. Undisturbed samples showed the material to be very little consolidated, particularly in the top 20 ft. (water content about 50 per cent by weight, voids about 75 per cent of total volume, submerged weight about 30 lb. and weight in air 92 lb. per cu.ft., average strength in shear about 60 lb. per sq.ft.). The sand and gravel from the hill, to be used in the fill weighed about 110 lb. per cu.ft.; the ashes and rubbish on Rikers Island about 70 lb. in air and 30 lb. submerged.

It was obvious that serious foundation displacement would occur when the heavier fill was used. Analysis and test results indicated that by carrying the fill forward in two layers, the first on slopes of 35:1 from just above high water to low water, foundation failure would be kept to a minimum. Such proved to be the case. Advantage was taken of the effect of the fill to squeeze the underlying silt out into Bowery Bay and thus secure a firm foundation for the bulkhead in the Marine Terminal and stable embankment along the east shore of Bowery Bay, which was not displaced by the subsequent dredging.

Considerable thought was given to the necessity for protecting the embankment from wave wash and erosion. Calculations indicated that this would not be serious and that such protection should be delayed until the edge of the field had consolidated and stabilized.

After various methods for moving the fill from Rikers Island to the airport site had been studied, steam shovels and trucks were adopted because of the variation in the material. Ashes, rubbish, iron bedsteads, stoves and scrap of all kinds, could not well be handled by conveyor or pipeline. A steel trestle with floating draw was built to provide a truckway from the island. How well and

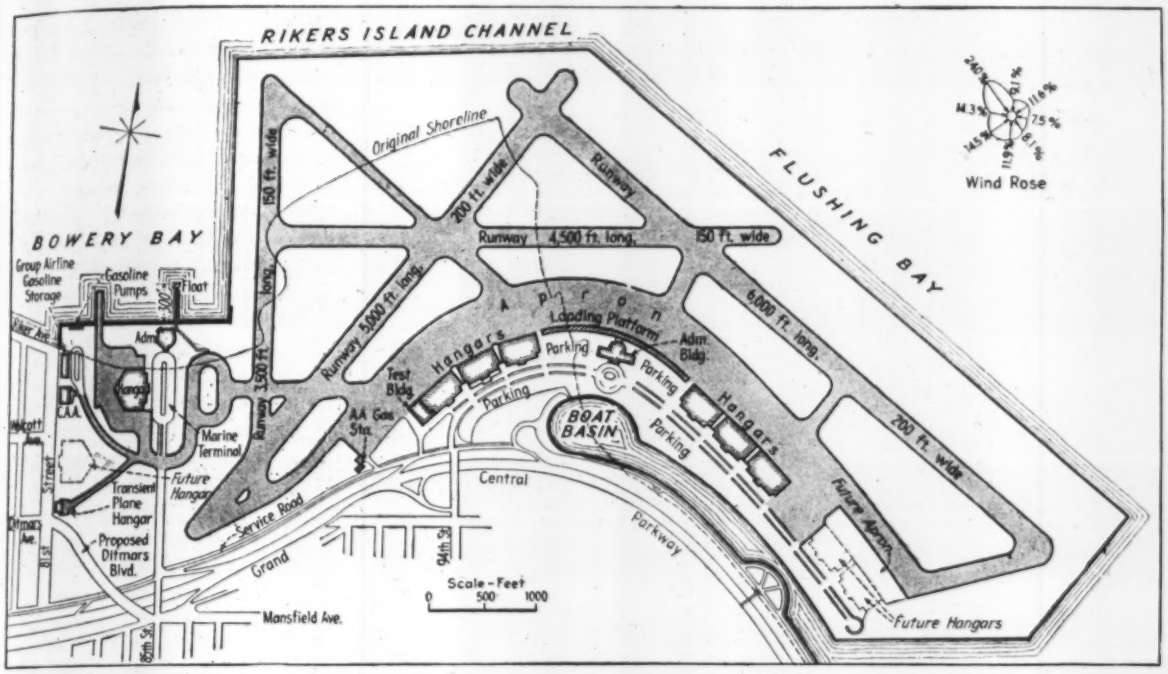


Fig. 4. Flying field layout at North Beach was developed from a runway plan designed for all service requirements with full regard to topography, obstacles and wind directions. The seaplane terminal, in the westerly part, was kept distinct from the land-plane terminal, but direct runway connections enable a land plane to make seaplane connections.

how rapidly this construction plan functioned was well described in *Engineering News-Record* of June 2, 1938, p. 779.

Long runways laid out

The runways (Fig. 4) are 6,000, 5,000, 4,500 and 3,500 ft. long. The two longest are 200 ft. wide, the others 150 ft. wide. Their great length and width were determined by the requirements for an instrument landing and by the probable increased size and landing speed of future planes. The transports now in use require about 1,800 ft. to attain sufficient air speed with only one engine. The additional length is provided as a factor of safety to permit the ship to be regrounded.

When instrument landing is perfected it will be necessary to come in at greater speeds. With greater mass and velocity the reason for the additional length in the runways designed for instrument flying seems clear. The 6,000-ft. runway is in the direction of the prevailing winds, the 5,000-ft. runway in the direction of the strongest winds. Though a width of 150 ft. is enough for safety in landing, the runways designed for instrument landings were widened to 200 ft. The added width will compensate for any lateral movement just before or after landing caused by light cross-winds. At the present time the radio range station is placed in prolongation of the 5,000-ft. strip because of the approach and because bad weather may be expected on it more often than on the longer one.

Though unrestricted expansion of the field was not possible, the limits and outline of the area were not restricted to the same extent as would have been the case on a predetermined plot of ground. In general the runways were first laid out, to meet the requirements of the site and service, and then the area to be reclaimed was determined by adding a generous margin beyond the runway limits.

Runway paving of concrete would have been desirable, but with green fill on soft foundation a non-rigid pavement had to be used. As finished this is equivalent to a 5-course asphalt macadam 12 in. thick.

The apron in front of the land-plane hangars and administration building is 400 ft. wide to permit easy passing of planes in front of the loading platform or hangars. Where laid in cut, the pavement of the apron is 7-in. concrete laid in slabs 20 ft. wide with doweled expansion joints every 100 ft.; on fill it is asphalt macadam.

Taxi strips 100 ft. wide, paved like

Fig. 5. View of a land-plane hangar from administration building. Top of curved loading platform is an observation deck.

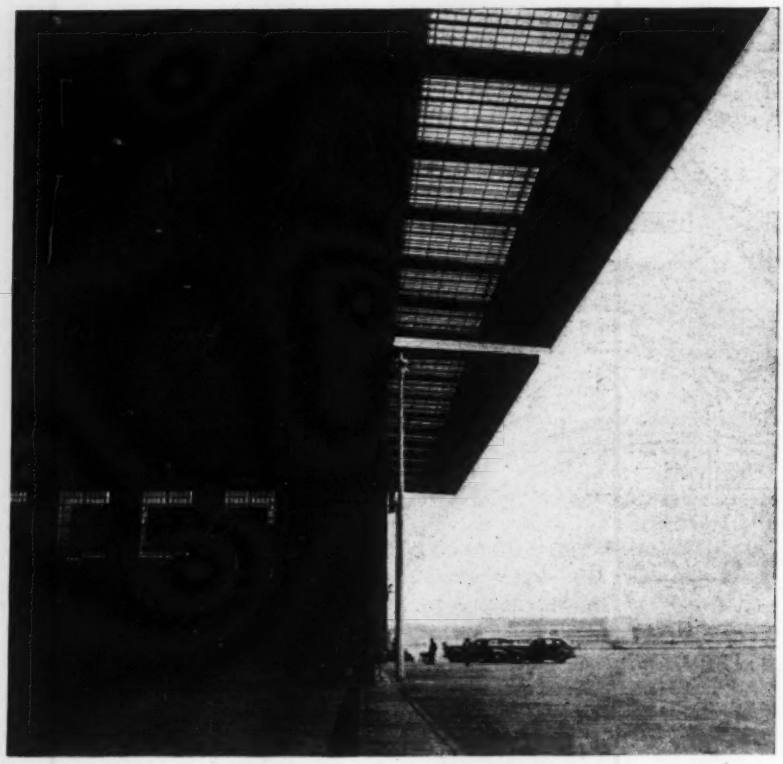


Fig. 6. Fifty tons of material went into these doors, each of which are made up of 2 sections hinged to each other. Grilles at sills are heating vents.

the runways, connect the apron and runways at such intervals as will minimize ground travel. A unique feature is a taxiway connecting the land and marine bases, which permits transfer of passengers from sea to land plane without leaving the shelter of the Marine Terminal building and also permits the use of the field by amphibians. It furnishes a connection between the runways and the small itinerant flyers' hangar and Civil Aeronautics building, both located along the westerly boundary.

Elaborate drainage system

Drainage of an area of such extent necessarily involves an elaborate system. Three separate systems were installed, one to lower and discharge the groundwater, another to dispose of surface water, a third for sanitary sewage. Subsurface drainage is collected in perforated corrugated iron pipes laid in trenches filled with broken stone which lie along the edges of runways, taxiways, and aprons. At intervals of about 400 ft. are junction basins, from which water is carried through concrete or vitrified pipes to 14 outlets.

The stormwater system is provided with catchbasins about 200 ft. apart, discharging into the same outlets. The system can handle a rainfall of 1 in. per hr., about double that of most storms in this vicinity.

Ten kinds of field lighting

The field lighting is an extensive system designed to afford the maximum safety in the use of the airport. In all there are ten different kinds of lights.

First, the field is outlined by prismatic amber boundary lights spaced 250 ft.; alternate lights are connected to different circuits, so that if one fails the boundary will still be marked by lights 500 ft. apart. Second, there is the system of contact lights which outline the runways proper. These lights are of the flush type and are so connected that only one runway can be illumined at a time. To help the pilot gage his distance the first half of the runway has white lights and the second half amber.

At the ends of each runway are cone-type green range lights, the number corresponding to the number of the runway. Also at the ends of the runways are two pencil-beam floodlights each of 7,500,000 cp. The intensity of these beams may be regulated in three steps by the operator in the control tower. Similarly, banks of floodlights are available to illumine Bowery Bay for the seaplanes. Floodlights are spaced in front of the hangars and loading platform to furnish illumination for the apron. Treadle-operated traffic lights protect the ends of runways 2 and 4 as well as the same runways from the Marine Terminal taxi strip.

Neon obstruction lights are placed atop all buildings. On the southwesterly approach, for a distance of 3,000 ft. from the field neon lights 7 ft. long spaced 200 ft. apart furnish the incoming pilot a lighted path to the end of the runway. A wind tee in the northwest corner of the field is also illuminated to give the pilot the direction of the wind.

Atop the control tower is the 13,500,000-cp. beacon which marks the field. Roadway and parking lights operated by automatic time switches furnish the illumination for pedestrian and auto traffic. The power circuits for the entire field lighting systems are independent of the building light and power system and are carried through a vast network of underground conduits with control in the observation tower.

Radio control and other aids

Complete instrument landing systems have not yet been fully developed. Arrangements have been made, however, for the installation and operation of such systems when approved by the Civil Aeronautics Authority. At present there is in use all that has been approved. When the pilot passes over a radio range station 3.4 mi. southwest of the field he receives a signal, and when halfway to the field he receives another signal from a fan marker, to judge his position and regulate his flight.

Other features of the field, aside from the buildings, are the water system, the telephone system, the gas system and the roadways and parking areas. Water is supplied to the land plane area through 16-in. and 12-in. mains at the center of the field and thence through a 24-in. main which is reduced to 18 in. Two 12-in. mains feed the 16-in. line for the marine base. All are interconnected by a 16-in. line to eliminate breakdowns.

The whole field is adequately supplied with telephones, the lines being carried through an extensive system of conduits and cables.

Gas is supplied to the field at 94th St. by a 17-in. connection to the mains of the Brooklyn Union Gas Co., and at the Marine Terminal by 4-in. connection with the Riker Ave. main. Gas is supplied to hangars and terminals for hot water heaters, pilots in furnaces, kitchens, laboratories, and heaters in booths along the loading platform.

Roadways and parking

Roadways and parking areas (Fig. 4) are paved with 7-in. asphalt macadam. Access to the field is obtained by two cloverleaf connections with Grand Central Parkway and a connection with the extension of Ditmars Ave. The marine and land bases are connected by a highway paralleling Grand Central Parkway, making it unnecessary for intra-airport traffic to enter or cross the parkway.

Parking space is provided for 1,600 cars. This is more than sufficient for the working force of some 1,500 and the travelling public. However, the space provided for sightseers has proved to be totally inadequate. Crowds of over 100,000 even in winter months have not been unusual on Sunday. If this interest continues additional space must be provided for parking as well as for connections with the city highway network in order to avoid present congestion.

All of this work, statistically as well as realistically of enormous extent, has been done by the WPA with the exception of the bulkhead and seaplane ramp, which, because of the necessity for using special heavy equipment, were done by contract under the direct supervision of Commissioner John MacKenzie of the Department of Docks.

Major Structures at the Airport

IN KEEPING WITH ITS FUNCTION as the union air terminal of the metropolitan area, La Guardia Field is equipped with station, hangar and service facilities of unusual completeness. Everything necessary for the ease of passengers and planes has been provided on the basis of careful planning for sea and land traffic, domestic and foreign.

Buildings authorized to date include a content of 35,306,164 cu.ft., and of this 34,359,164 cu.ft. have been constructed. Major structures already built are the administration building, six land-plane hangars, the marine terminal, a seaplane hangar, an airline operations building, a high pressure pumping station, two machine shop and test buildings, a maintenance building, and two gasoline storage and pumping stations. Work is just being started on a hangar for itinerant flyers and a building to house the regional offices and hangar of the Civil Aeronautics Authority. Two additional land-plane hangars and one seaplane hangar awaiting authorization will bring the total to 48,739,714 cu.ft.

The curved alignment of the land-plant structures (see Fig. 4) was dictated by the presence of the boat basin and the necessity for keeping the buildings 750 ft. from the runways. The marine terminal was fixed by the necessity for having access to 12 ft. of protected water, which could be provided more advantageously at the west end of the field than anywhere else. The separation of sea and land traffic and their convenient interconnection are layout features.

The type of architecture, according to the architect, W. A. Delano, utilized traditional motives in a manner appropriate to the purpose. The Bureau of Air Commerce (predecessor to the CAA) limited the height of the buildings to 70 ft., which led to a low streamlined appearance fitting to the flying service. The result has been characterized by the profession and the public as distinguished.

Engineers will be more concerned with structural and mechanical features of the buildings. A. D. Crosett was responsible for the former and Syska & Hennessy for the latter. Their work was necessarily adapted to the basic features of the design.

Main terminal buildings

The administration building had to provide offices for the Superintendent of the airport, the Civil Aeronautics Authority, the Weather Bureau, the various airlines, ticket offices, waiting rooms, rest rooms, restaurants and other facilities for passengers, baggage and mail and express. Consideration also had to be given to the practice of bringing a large proportion of the passengers by bus from the Grand Central Station, where formalities with respect to tickets and baggage had already been settled. These passengers need not and should not be routed through airport ticket offices and waiting room. This problem as well as separation of incoming and outgoing passengers was solved

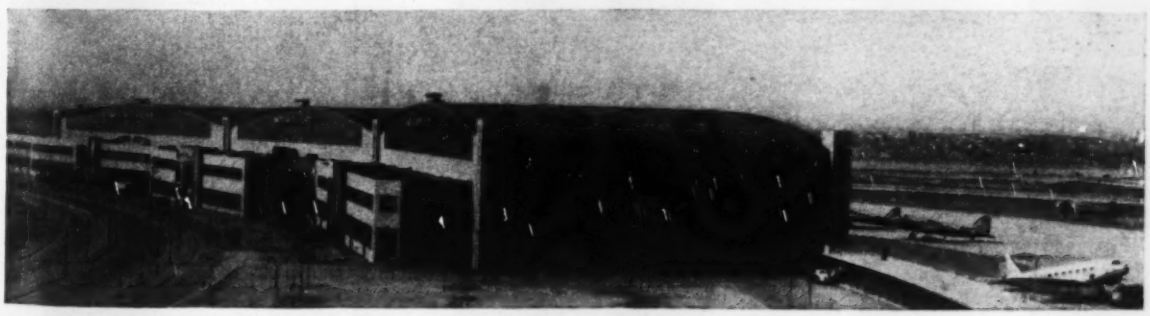


Fig. 7. A group of three hangars to the west of the administration building. Another group is located in a similar position on the east. Note end of loading platform at right.

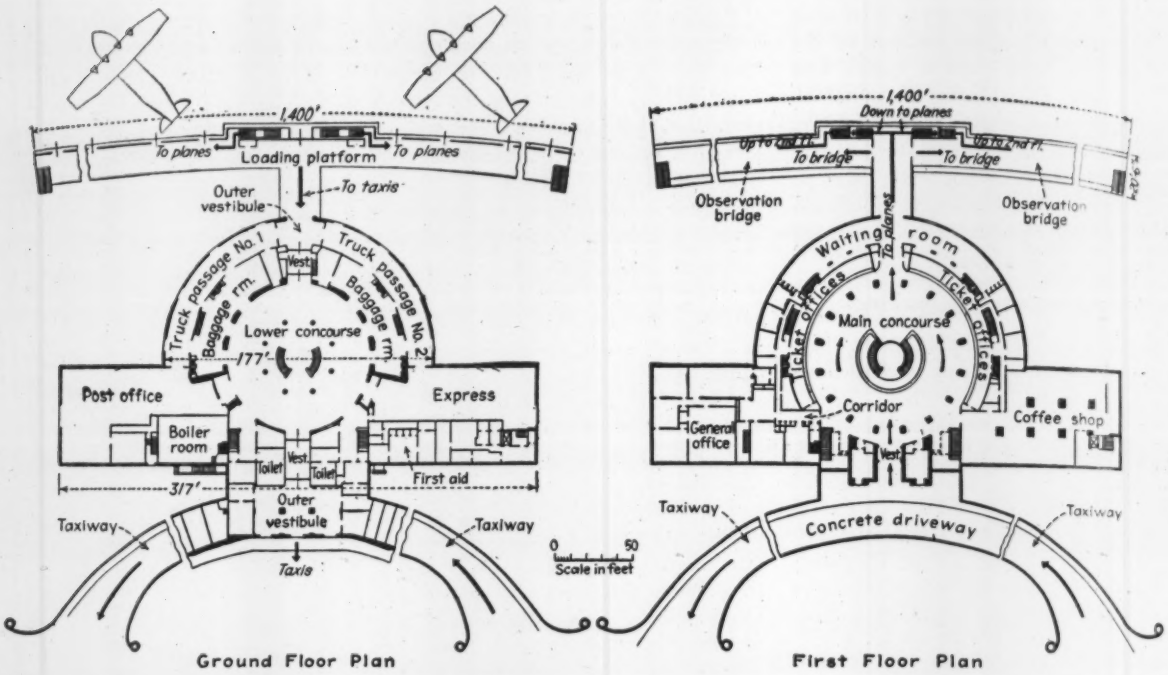


Fig. 8. La Guardia Field centers on the huge land-plane administration building (in the foreground of the view Fig. 1), laid out to accommodate arriving and departing passengers in separate floors without interference with each other.

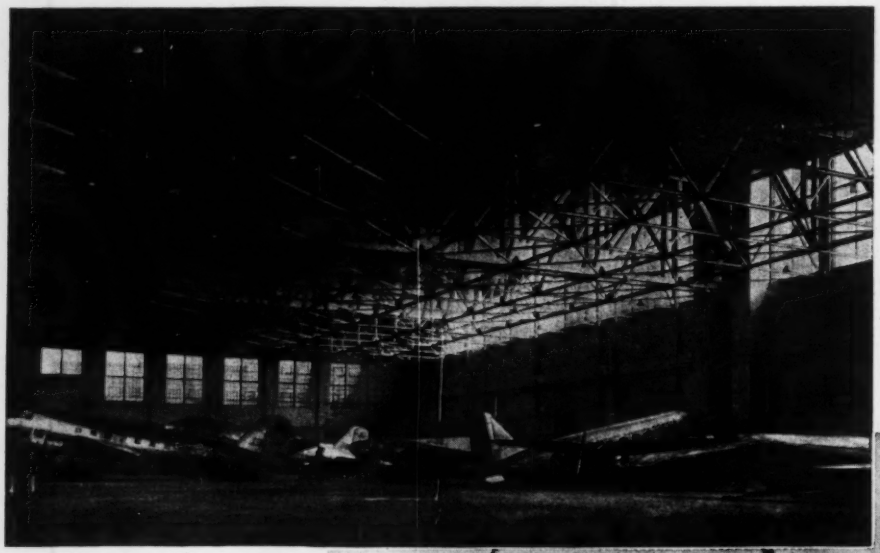


Fig. 9. Absence of interior columns is a striking feature of the hangars at North Beach. In each hangar two 165-ft. bridge-like trusses are framed into double columns at the front and back walls. These carry lighter trusses framed into the sidewalls.

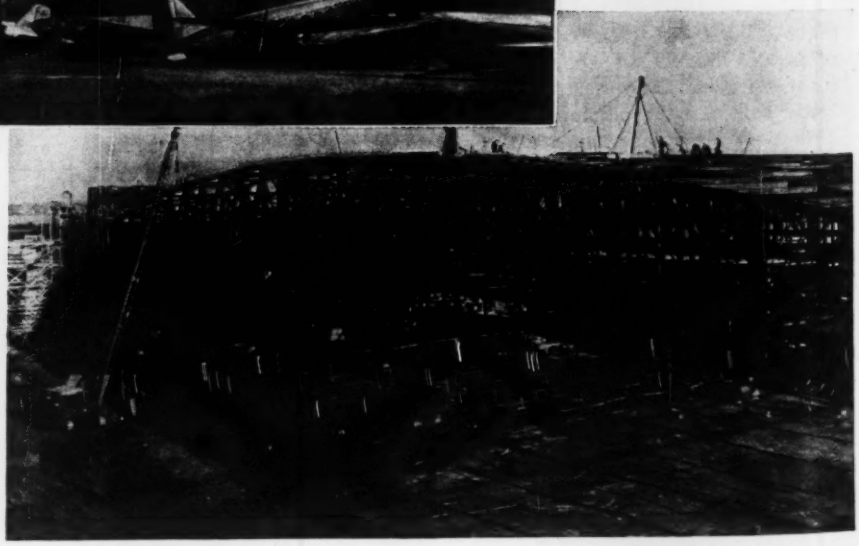


Fig. 10. An idea of the size of the front and back center double columns in the hangars is obtained from this illustration. In the finished building the open door width on each side of the front column is 163 ft. 5 in.

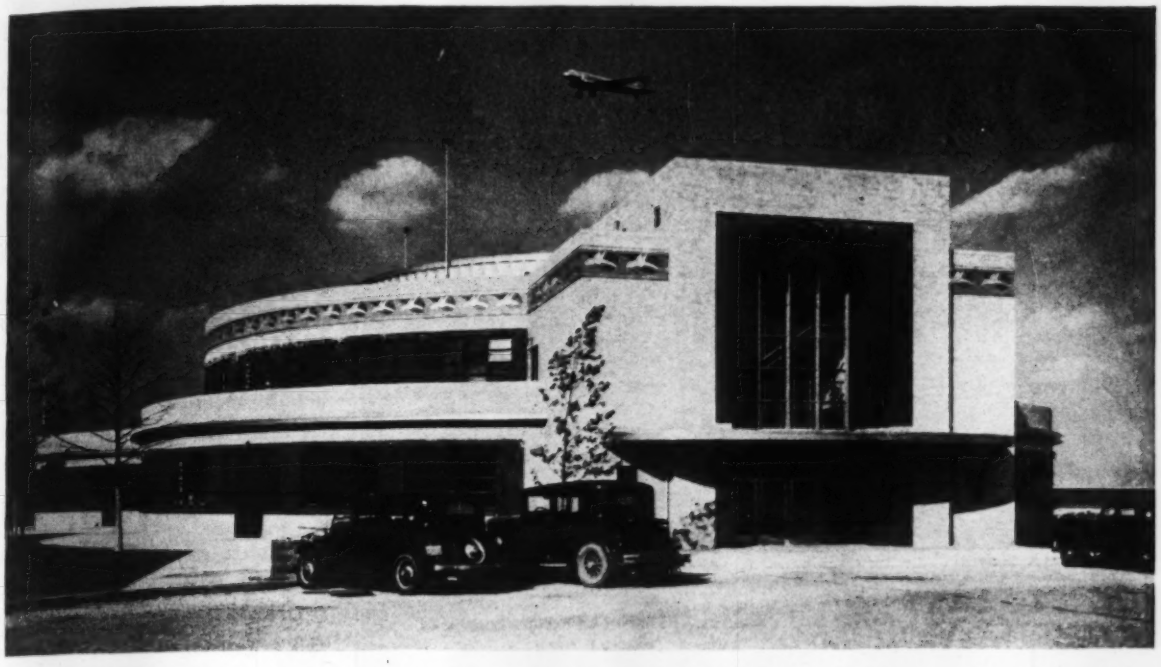


Fig. 11. A frieze depicting flying fish fittingly adorns the marine terminal building. The building was designed for efficient movement of passengers through customs, health and immigration facilities.

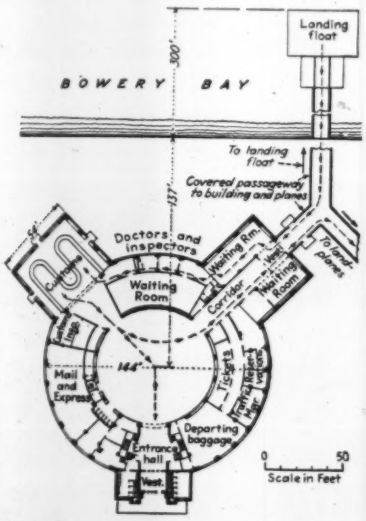


Fig. 12. Smaller than the land-plane terminal but yet of imposing size, the marine terminal building affords special facilities for immigration and customs inspection. Enclosed arcades connect the building with the landing float and with a special land-plane apron.

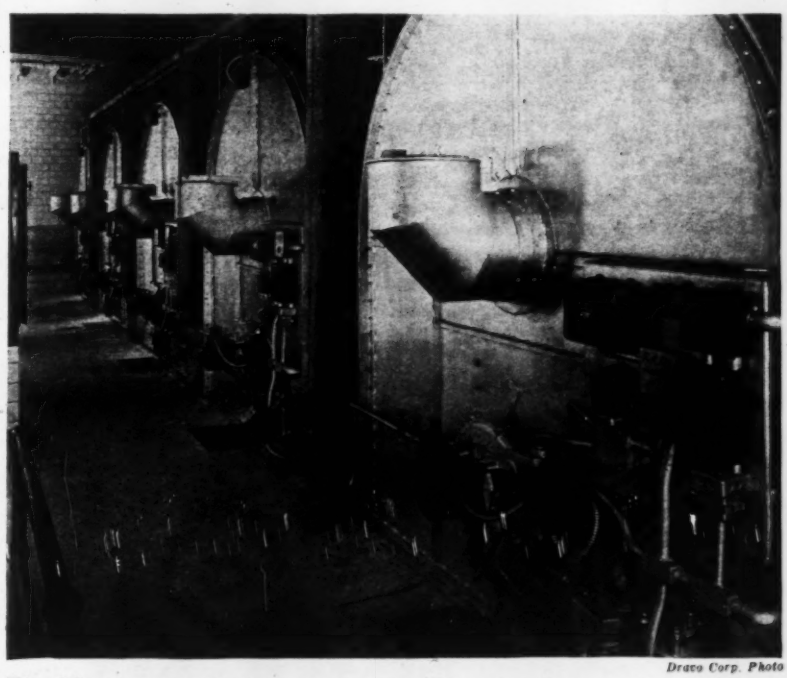
by the space arrangement of the terminal.

Baggage, mail, and express move without crossing the stream of passengers at any point inside the terminal. Buses drive direct to the gates along the loading platform, where booths are provided for handling any last-minute formalities.

A unique feature of the 1,500-ft. loading platform is the promenade deck (see section in Fig. 16) for the use of those meeting their friends or seeing them off and for sightseers; it eliminates the usual crowding around gates. The location of restaurants, ticket offices and other facilities as well as the movement of passengers will be apparent from a glance at the plans. It may be remarked that the diameter of the central circular hall is only 10 ft. less than that of the rotunda of the Capitol.

Marine Terminal

The interesting feature of the lay-out of the Marine Terminal, also built around a central circular hall,



Draco Corp. Photo

Fig. 13. Five of six hot-air heating units in the seaplane hangar. Each unit delivers 35,000 cfm. The oil burners use heavy oil.

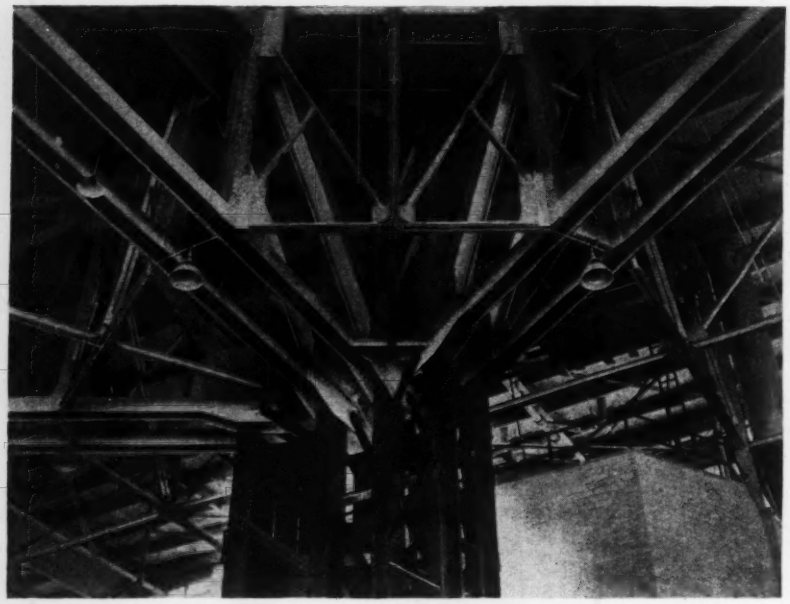


Fig. 14. Unique roof truss framing into the central column in the marine hangar.

AIRPORT DATA

Airport area	558 acres
Fill	17,300,000 cu. yd.
Buildings	969,800 sq. ft. floor area
Buildings	35,306,164 cu. ft.
Hangar doors, weighing 25 tons per pair	16 pairs
Concrete	104,900 cu. yd.
Concrete piles under buildings	9,012 piles—135 miles
Brick	13,700,000
Carloads of cement	1,020
Steel	20,400 tons
Reinforcing steel	3,700 tons
Duct lines	800,000 lin. ft.—160 miles
Cable	1,000,000 lin. ft.—200 miles
Wire	2,000,000 lin. ft.—400 miles
Underground piping	115,000 lin. ft.— 25 miles
Fire pumps	6 of 2,000 gal. capacity each
Storage tanks, 40, total capacity (Gasoline & Oil)	647,000 gal.
Runways and taxi strips	90 acres—3⅞ lineal miles
Aprons	53 acres
Crushed rock	450,000 cu. yd.
Asphalt	3,000,000 gal.
Kilowatts of power	6,040—700 miles of street lighting
Planted and seeded areas	375 acres
Trees planted	467
Topsoil used	225,000 cu. yd.

DEPARTMENT OF DOCKS CONTRACTS

Bulkhead	J. Rich Steers, Inc.	1763 lin. ft.
Ramp	Charles F. Vachris, Inc.	354 lin. ft. x 42 ft. wide
Piles	Raymond Concrete Pile Co.	9,012 piles
	Charles F. Vachris, Inc.	
	Fehlhaber Pile Co., Inc.	
Dredging	Arundel Corp.	1,263,000 cu. yd.
	Charles F. Vachris, Inc.	

is the arrangement for the passengers' movement through immigration, health, and customs formalities, and the covered passageway connecting with stations for both land and seaplanes (Fig. 12).

In structural design, both buildings have a structural steel frame supporting the roof and floors. The exterior walls are of black and buff brick, the floor arches and fireproofing of cinder concrete. The live loads used in design are 100 lb. per sq. ft. for public spaces, 50 lb. for office spaces. Exterior walls are self-supporting with a running band of clipper headers every sixth course. Metal wall ties throughout furnish additional bond. The interior glazed tile are bonded every sixth course by a course of alternate headers and stretchers.

These buildings, as are all others, are supported on concrete piles. Owing to the fill subsoil and the number of trenches below grade required to accommodate mechanical equipment, a concrete mat supported on piles 3 ft. below the finished floor was provided. Pipe trenches were constructed on this mat, the intervening spaces being filled with lean cinder concrete.

The land-plane hangars are in two groups, 1, 3 and 5 being to the west and 2, 4 and 6 to the east of the Administration Building. Aside from differences in detailed layout the groups are distinguished structurally by the fact that the floors of 1, 3 and 5, being on fast land, are laid on the ground, whereas those of 2, 4 and 6, being on fill, are reinforced-concrete flat slabs supported by piles 12 ft. on centers.

The hangar sections are 350 ft. long, 165 ft. deep and 42 ft. high to the roof trustees, and have no interior columns. However, with the doors on the longer side of the building, it was possible to install a column at the centerline between the doors. This permitted the use of two heavy trusses front to back at midlength, spanning 165 ft., to support the 175-ft. longitudinal trusses. Since the architectural design called for an arched roof, the location of the truss at the highest point permitted maximum depth and economy of design.

Each hangar has four doors, hung in pairs on either side of the centerline column, giving a clear space of 163 ft. 5 in. on each side. Each door is in two horizontal sections. The sections are counter-balanced and operate so that the lower half rises

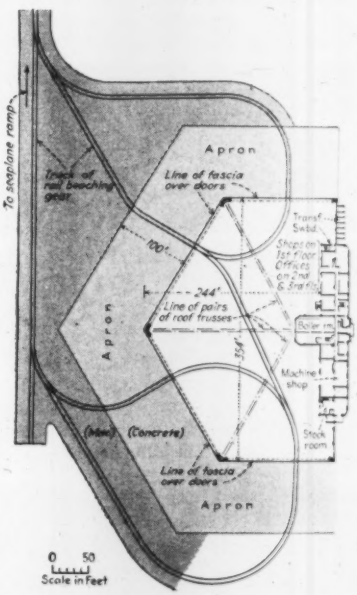


Fig. 15. Design for extension in four directions makes the seaplane hangar unique from both operating and structural viewpoints. Tracks for the beaching gear enable planes to be brought in through any one of the four vertically folding pairs of doors. The design for extension led to the remarkable steel framing detail, Fig. 14, where the three pairs of radial trusses are carried by a single tower column.

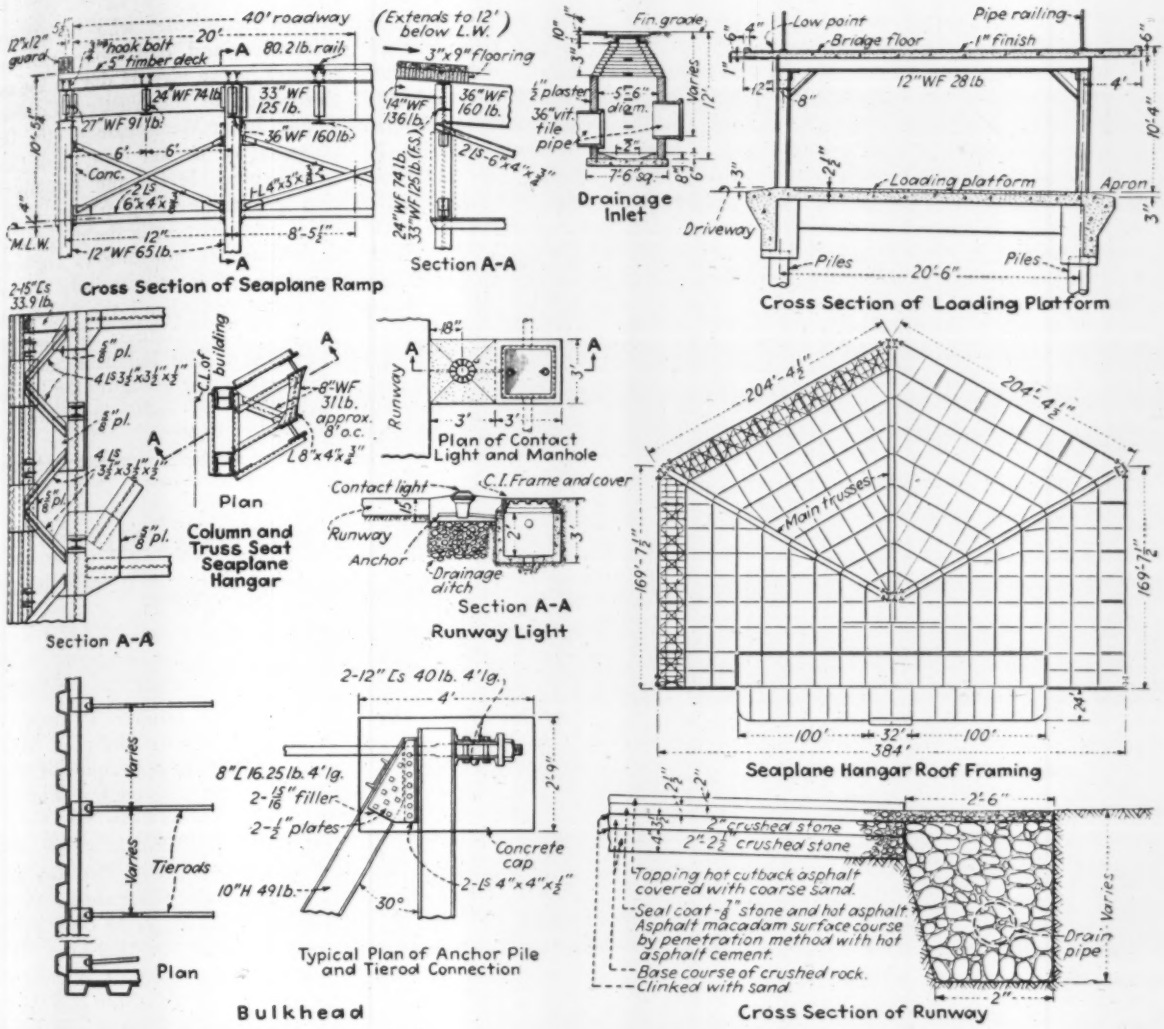


Fig. 16. Some of the important details of field and structures at North Beach Airport.

its full height when the two leaves pivot outward to leave the entire storage space clear. Each door section operates independently, the entire operation requiring 1 min. The doors are steel, have a large percentage of glass area, and are designed to withstand a pressure of 30 lb. per sq. ft. closed and 15 lb. per sq. ft. when operating. The great height of doors and hangar is to permit the housing of the larger planes of the future.

In addition to the light admitted to the hangars through the doors, windows set high in the walls and above the office space supply an unusually large amount of light for the interior. Hammered blue glass, "coolite", 1/8 in. thick, is installed on the south side of the hangars to reduce glare during the summer months.

The plan of the seaplane hangar provides for hangar doors on four sides. It will be noted that the shape of the building permits the extension of these four sides should the increased size of the planes require this. The roof is supported on three main trusses, carried by columns braced to form a tower for supporting the heavy concentration of trusses and also of developing bending resistance against the wind pressure. The roofs are of 2-in. gypsum plank supported on steel purlins.

The mechanical installation for these structures was necessarily extensive. One of the most interesting features of this part of the work was the heating system. With a concentration of buildings of this type the situation might seem ideal for a central heating plant. Because of the number of tenants and for technical reasons this proved not to be the case.

The installation selected is a hot air system, with furnaces of welded steel plate type, automatically oil fired, each rated at 100 BHP and equipped with two blowers and one induced draft fan on a common shaft. Each delivers 35,000 cfm and is interlocked electrically with the others in the hangar. There are four of these units in each land-plane hangar and six in the seaplane hangar. The capacity in each of the hangars is enough to raise the temperature in the hangar space from zero to 55°F. in 25 minutes after the doors are closed.

Ducts are located just inside the doors, and electrical interconnection between doors and furnaces automatically causes a supply of hot air when the doors are opened, thus tending to seal the warm air in the building. The air is recirculated and

returned to the furnaces through louvers set in the central furnace-room walls.

The administration buildings are heated by two-pipe low-pressure steam systems with vacuum return.

In hangars 1, 3 and 5 the shop and office space has been completely air conditioned. All hangars are equipped with sprinkler systems supplied by a high-pressure pumping station located between hangars 3 and 5. A reserve supply of 300,000 gal. water is kept in tanks in the building; this with the numerous interconnections in the mains is believed adequate to supply the seven high-pressure electrically operated pumps in the station. The pumps may be operated by direct-connected gasoline motors in the event of electric supply failure. Steamer connections outside the buildings are also provided.

Electric power

Electric service is supplied through four feeders of the Consolidated Edison Company. Power at 27,000 volts is distributed from four transformer vaults, each building being provided with two independent services. Lighting within the hangar space is furnished by alternate 750-watt mazda and 500-watt mercury vapor lamps 20 ft. on centers; the combination gives a bright and pleasing illumination approximating daylight. The fixtures in the office and shop spaces are for the most part of the semi-direct type, though some rooms are supplied with direct and some with indirect fixtures.

Provision is made for bringing gasoline to the airport by barge and for discharging it through pipelines into storage tanks. As will be noted in Fig. 4, near the bulkhead at the westerly edge of the field is a gasoline storage building housing eighteen 20,000-gal. tanks with the necessary pumps, foamite equipment and loading apparatus. This building serves the marine terminal by pipeline and the eastern group of land-plane hangars by truck.

A separate storage building to serve hangars 1, 3 and 5 was erected west of those hangars. It has provision for seven 15,000-gal. tanks and necessary equipment. These tanks are connected by pipeline to the Bowery Bay bulkhead and on the delivery side by pipelines to pits in front of the hangars where planes are fueled.

Fuel oil is stored in underground tanks adjacent to the buildings which they serve. As a rule these are of 15,000-gal. capacity for the large buildings and from 2,000 to 5,000 gal. for the smaller structures. The aggregate fuel-oil tank capacity is 182,000 gal. making the total for gasoline and oil 647,000 gal.

A statistical summary of the work accomplished by the Work Projects Administration at the New York Municipal Airport as described in this and the two preceding articles will be found on p. 462.

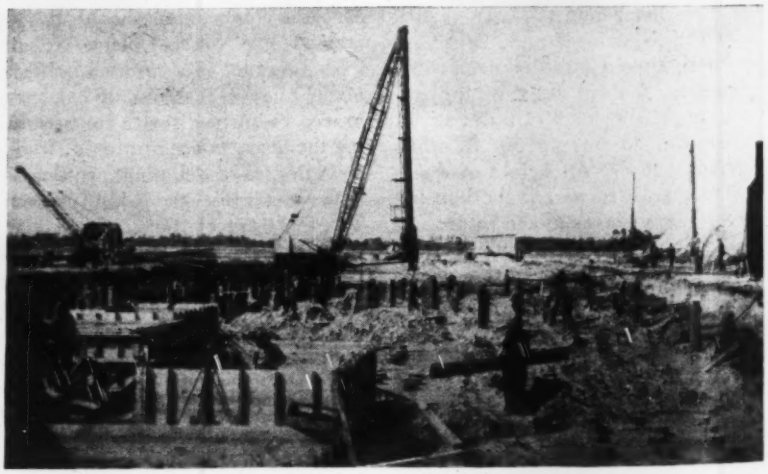
Construction of New York's municipal airport was sponsored by Mayor LaGuardia, who maintained an active and continuing personal interest in the airport during the entire period of construction. Commissioner John MacKenzie of the Department of Docks, New York City, was responsible for the administrative and engineering phases of the city's participation in the project. His department in addition to engineering inspection was entirely responsible for driving all the foundation piles for the buildings, for the construction of the bulkhead and seaplane ramp, for dredging the turning basin, and for radio installation.

Notes on Construction In Southern States

From correspondence with a staff member on the move.

Tampa, March 5—The Navy air base at Piney Point on the St. Johns River above Jacksonville, Fla., a $15,000,000 project, is just getting under way. The Standard Dredging Co. has completed the dredging of the 5½-mile channel up the river from Jacksonville and now is engaged in dredging a turning basin at the air base, pumping the dredged material inland to fill low lands that are included in the base. Harvey & Quina of Pensacola have started work on the bulkheads and piers along the river frontage and Hillyer & Lovan of Jacksonville are driving piles for the first unit of a big concrete storehouse. In all, nine contracts totaling nearly $2,000,000 have been let, and plans and specifications for many others are under way. The state highway department has begun the relocation of U. S. 17 to clear part of the site taken for the base. Three months hence, when it is good and hot in Florida, this base and the one for the Army at Tampa will be beehives of construction activity.

The new base will serve both land and sea planes. The latter will use the St. Johns River which is more



Driving piles for foundations of a reinforced concrete warehouse at the new Navy air base at Camp Foster, south of Jacksonville.

than two miles wide at the site. A fine field for land planes can be made with little grading once Piney Point has been cleared of scrub pine.

New type of lock gate

C. Nelson, senior engineer of the U. S. Engineer Department at Clewiston, was waiting for me at West Palm Beach to show me their work on Lake Okeechobee and its connecting waterways. We drove north along the coast some 30 miles and then cut inland to old Lock No. 2 on the St. Lucie Canal where the U.S.E.D. is building a new lock to replace the two old and very small locks in that waterway connecting Lake Okeechobee with the Atlantic Ocean.

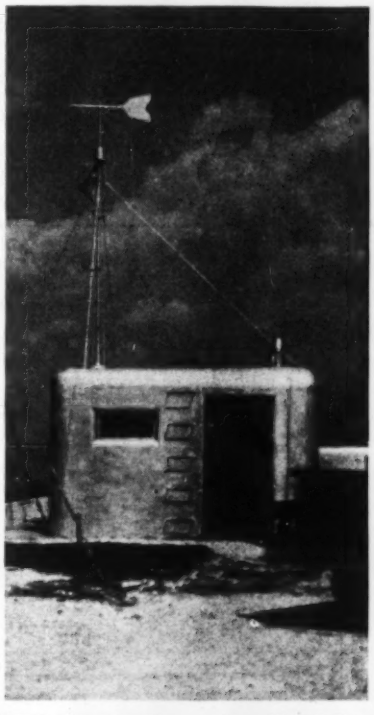
This lock, like the ones on the Caloosahatchee River west of the lake, has sector type gates instead of the usual mitre gates, a new type of gate that has been under development by the U.S.E.D. for a few years past. The hurricane gates on Lake Okeechobee are of similar design. The new type is similar to the sector gates used on dams but the axis is vertical. It requires more concrete to form the gate chamber but has the great advantage of being able to be opened or closed against a head of water, thus permitting use of the gates for filling and emptying the lock. This eliminates all the costly filling and emptying passages in the walls and floors and all filling valves and control gates.

From the lock we drove west to the lake and onto the levee, following its crest to the south to see the levee reinforcement work that now is in progress.

Levees on Lake Okeechobee

The first levees around Lake Okeechobee were thrown up after hurricanes in 1926 and 1928 had swept great storm waves out of the lake into the small settlements on the fertile muck bottoms of the Everglades that extend south from the lake. The loss of life was around 2,000. Today, given a new sense of safety by the levees, many more people have settled around the lower rim of the lake. It is to give them greater security that the government is raising the levees and reinforcing them with limestone rock dredged from the lake bottom. How that work is being done and some of the interesting experiments that have been made to protect the levees against wave action when high winds sweep across the 30-mile-wide lake will be told in more detail later.

Hurricane gates have been built in the levees at each of the several points where canals lead out into the Everglades. These gates can be closed quickly in event of a storm. No one now knows much about wind and water conditions during a hurricane, but the Army engineers plan to get accurate data in the next storm on Okeechobee. At each hurricane gate they have built a "pillbox" on top of the levee and have installed in it self-recording gages which take current records of wind direction and velocity, barometric pressure and water levels in the lake. The wind gages are of a new type designed for this work by Julien P. Friez & Sons, to eliminate the revolving elements of anemometers that generally fail in winds of hurricane velocity. The new type will record wind velocities up to 200 mph by measuring pressures developed on a small orifice at the end of a vane held into the wind. During hurricanes, operators are to be put in these gage houses to observe conditions and report by short-wave wireless to the headquarters at Clewiston.



"Pillbox" on the Lake Okeechobee levees, a weather recording station designed to meet hurricane conditions.

On Saturday morning A. R. Broadfoot, principal assistant engineer, took me by boat from Clewiston out into the lake and up along the west shore to Moore Haven. The lake on that side is very shallow and navigation moves along the toe of the levee in the channel cut in building the levee. On the lake side is marsh land on which the engineers of the district are planting a windbreak of Cajeput trees, an Australian tree that grows rapidly and does not mind having its feet wet most of the time.

At Moore Haven we left the lake going west to Fort Myers through the Caloosahatchee River, now a dredged and straightened channel through which fair sized boats can come from the Gulf of Mexico up into the lake. It has two locks, one at the hurricane gate at Moore Haven and one farther west at Ortona. Both are relatively new and similar in design to the new one on the St. Lucie Canal.

The day before we went through the canal the lock tender at Ortona said he had locked 61 boats through. Nearly all were pleasure boats and yachts of people who can afford to spend their winters cruising in southern waters; not one paid a cent of toll for the use of the waterway that Uncle Sam has built for their convenience. It just does not make sense!

Frost damage to roads

Tallahassee, March 6—J. H. Dowling, state highway engineer, states that old roads in north Florida suffered badly in the cold spell. Surface treatment on 518 miles of road that had been down more five years was so badly damaged that nearly three million dollars must be spent at once in order to save the present investment. As Florida operates on a pay-as-you-go basis, finding that amount of money is not easy.

The damage was confined to the older surface-treated limerock roads, as far south as Tampa; newer roads and the sand-clay roads were not affected. Florida has had as low temperatures before, but has never had as long a period in which one freeze followed another in quick succession. The roads were wet when the first freeze came and the highway engineers think that it opened up the old weak surfacing. The following thaw let the water down into the road where subsequent freezing and thawing continued the disintegration.

In the reconstruction work, a sand-bituminous mix will be substituted for the surface treatment on part of the work.—V.T.B.

FROM FIELD AND OFFICE

Working problems and time-saving methods . . . Edited by Charles S. Hill

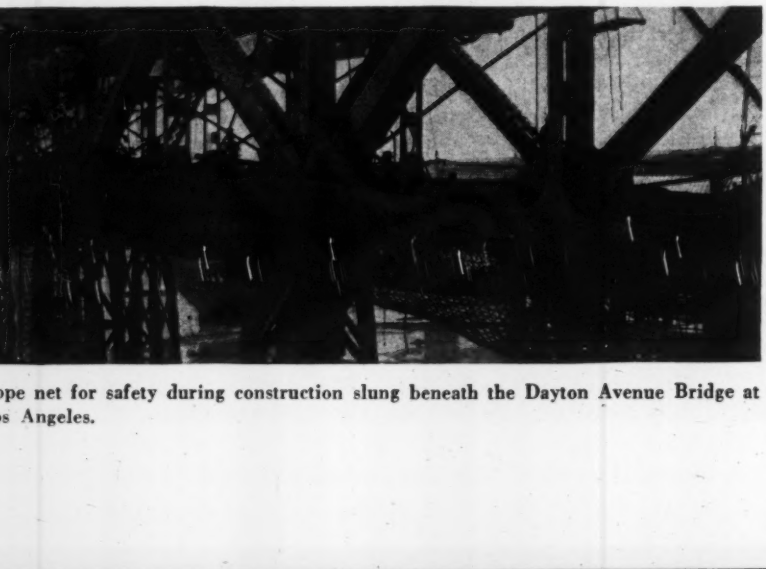
Another Bridge Uses Safety Net

A portion of the rope net that was used as a safety precaution during construction beneath the deck of the Golden Gate Bridge at San Francisco recently was used again on the Dayton Avenue Bridge erected across the Los Angeles River by the U. S. Engineer Department. This structure is a 238-ft. steel truss crossing the river at a point where the channel is bordered by concrete walls that extend up some 45 ft. above the river bed. The total cost involved in use of the net on this job for a period of about four months was something more than $2,000.

As payment for the net was on a weekly basis, it was proposed to remove it as soon as the steel was up. When the time for removal came, however, the painters objected strenuously and it was found that they were using the net not only as a means to safety but also in lieu of scaffolding; in places they were standing in it to paint the steel. The net was therefore left in place until painting was finished. However, it should be noted that the net cost (no pun intended) chargeable to safety was the total cost less the cost of staging which otherwise would have been required for painting.

When the net was brought to the job, steel erectors were inclined to scoff, but before the work was finished it was apparent that the "in-the-way" objection was not valid and the opinion of the directing heads was that it would have been worth the cost to make use of a rope net of this sort on similar jobs.

The work is under the supervision of Col. Edwin C. Kelton, U. S. Engineer Department.



Rope net for safety during construction slung beneath the Dayton Avenue Bridge at Los Angeles.

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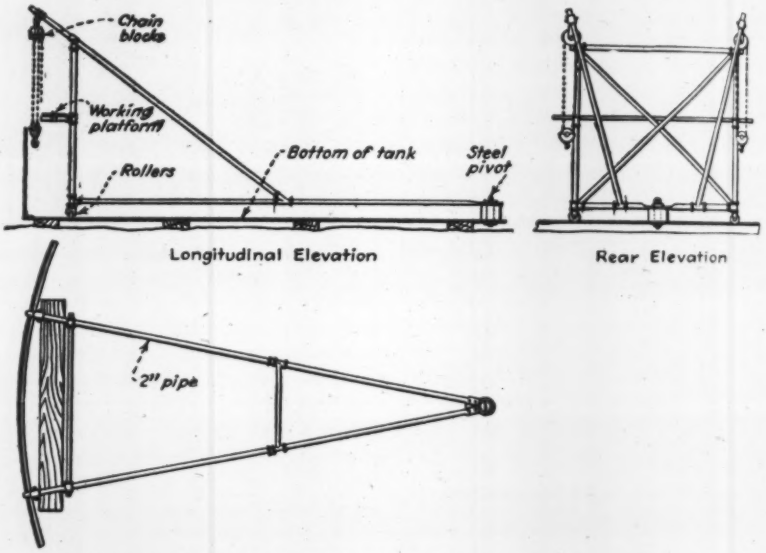
Simple Revolving Scaffold Speeds Steel Tank Erection

IN ERECTING a dozen or more steel tanks at the Mary mine near Silver Peak, Nev., for use in a flotation-cyanide mill, it was necessary to find some convenient portable scaffold for lifting and bolting in place the successive courses of metal plates. A convenient scheme was evolved, as shown in the accompanying drawing, built up from material on the job, principally 2-in. pipe.

After the bottom of the tank had been laid, a small hole was made at the center for a bolt that would serve as a pivot about which to swing the rotating scaffold. A chain block was attached at each of the two elevated ends of the scaffold sector and a working platform was arranged to be clamped at any desired height.

With this job-made rig, erection proceeded much more rapidly and because the plates were easily raised and firmly supported while being bolted in place, there was less risk of injury to workmen.

The work was done for the E. L. Cord mining interests, owners of the Mary mine.



Plan and elevations of a rotating scaffold, job-made, used for erecting walls of tanks.

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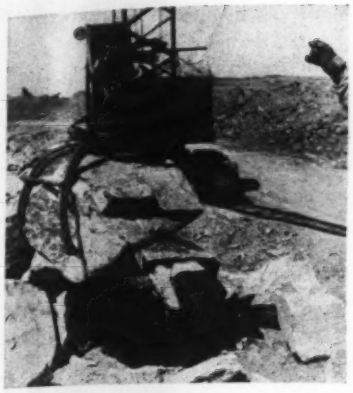
Job-Made Tongs Handle Rock

A three-pronged set of tongs for use in lifting rock fragments larger than the two-man size and weighing up to 1,000 lb. was used in paving the outlet channel for the control works at Prado Dam in southern California. A small crawler crane moved along the excavation at the toe of the slope to be paved and here supplemented the work of the paving crew by placing the large rock.



Handy three-prong tongs in action.

In this way the work was speeded up and the facing was made more stable than would have been possible if only smaller fragments had been used.

The tongs were made of light steel shapes. The double prongs, somewhat lighter than the single opposing prong, had a steel reinforcing bar welded in horizontal position as a stiffener and to resist any tendency to separate the pair. Gripping was assured by attaching the crane hook at the center point of a chain loosely connecting the upper ends of the prongs.

The device was developed and used by J. B. Stringfellow, a subcontractor on the paving job.

• • •

Tractor Springs for Bucket Teeth

When a spring is broken in tractors operating at Shasta Dam the broken parts are carefully saved in the repair shop for use in renewing the teeth of buckets on power shovels. The material in these springs is of an excellent quality for this service and can be worked, after drawing the temper, into the shape required for the teeth renewals and then welded to the old teeth stubs. After final tempering the new teeth are fitted to the buckets.

• • •

Items To Be Checked In Dam Construction

Grand Coulee Dam affords an example of how recent improvements in the technique of concrete placement have increased the number of items to be checked by engineer or inspector as the work progresses. Thirty such items are listed on the "clearance card" used at Grand Coulee for recording signatures certifying to inspections. After the contractor indicates readiness for inspection, frequently two kinds of checking have to be done by representatives of the U. S. Bureau of Reclamation; ordinarily a field engineer takes responsibility for quantity and location of the item while an inspector checks quality, workmanship, etc.

"Rock," for example, is checked by the engineer for depth and amount of excavation while the inspector concerns himself with soundness of the foundation exposed. The item of foundation grouting includes work in three zones in which pressures range, respectively, up to 200, 400 and 1,000 lb. per sq. in. Testing watertightness of welds in copper stops, washing or blowing out piping systems to assure clear passages, and checking the location of piezometers and strain meters are just a few of the operations.

Because of the limitation on maximum allowable height differences of completed work and the desirability of minimizing transfer of equipment from block to block, a considerable problem is involved in laying out the most economical locations for successive pours.

For quick visualization of the whole project, a wood model of the dam is being slowly built in the inspector's office at Grand Coulee by tacking in place a small plywood block, cut to scale, as each successive 5-ft. lift is poured. The written record accompanying the model is based on a "clearance card," of the sort illustrated, for each block. When a card has the requisite signatures the block it represents is released to the contractor for the next pour.

CLEARANCE CARD

Time Started Pouring:_____ Block: _____

Time Finished Pouring:_____ Top Elev._____

ITEMS	INSPECTOR	ENGINEER	CONTRACTOR
Rock			
Foundation Grout Pipe			
Foundation Drainage Pipe			
Grout Stop			
Grout Pipe Washed			
Grout Pipe Outlets Tested			
" " " Secure			
" " Headers Tested			
" " Location & Quantity			
Grout Groove OK to Cover			
" " OK			
Cooling Pipe Washed			
" " Tested			
" " Location & Quantity			
Reinforcing Steel			
Misc. Pipe			
" Metal			
Porous Drain Tile OK to Wrap			
Porous Drain Tile Washed			
Drain T. Location and Quantity			
Technical Installation			
Electrical Conduits			
Ground Wire			
Expansion Joint Filler			
Patching			
Forms Oiled			
Forms OK			
Wash Water Drain OK			
Final Engineers' OK			
" Cleanup OK			

NOTE: TO BE DATED AND FULL NAME SIGNED IN COLUMNS AS ABOVE BY INSPECTOR, ENGINEER AND CONTRACTOR.

PLEASE RETURN THIS CARD TO O. K. BOX

Thirty items to be inspected and checked for each 5-ft. lift are listed on the "clearance card" used on each concrete block.

BOOK NOTES AND REVIEWS

The month's additions to the engineer's reading and reference list

A Useful Reference On Reinforced Concrete

REINFORCED CONCRETE DESIGN HANDBOOK—132 pp. Published by American Concrete Institute, Portland Cement Association, Concrete Reinforcing Steel Institute, and Rail Steel Bar Association. Price $2 from American Concrete Institute, Detroit, Mich.

The Reinforced Concrete Design Handbook prepared by Committee 317 of the American Concrete Institute is an unusual product of committee work and evidently embodies great labor and care. In scope it covers the design and investigation of flexural members, stirrups, columns under concentric and eccentric load, footings, and moments in building frames. It is a valuable reference book for an engineering office but is less well adapted to serve as a designer's handbook.

For rapid design a book with more ready working tables than are here given is needed, as for instance, tables of T-beams (beam with 12-in. width of slab) for different thicknesses of T-flange and different strengths of steel and concrete. The tables given in the present handbook for rectangular and T-beams provide excellent material on which to base more convenient working tables. Similar comment applies to column design tables; the engineer can design more rapidly if he has tables that give the concentric equivalent of a certain eccentric load, just as in the case of moment factors usually given in structural steel handbooks.

Excellent tables are presented for concentric loads on tied and spiral columns. Spread footings are treated in the right way, that is, by definite designs. However, they do not cover a sufficient range of variation in soil character and mix of concrete. Also, the footings do not appear to be economical, as no caps are shown, although these are commonly used to save concrete. The data on pile footings would be improved by giving designs for 20-ton wood piles and 30-ton concrete cast-in-place piles, to fit common practice.

The treatment of two-way slab design does not impress the writer as satisfactory. This really needs clearing up on the part of the joint committee; present formulas are too complicated.

The book should prove of great value in dealing with special problems and in developing further work tables for the structural designer's desk. — Reviewed by ELWYN E. SEELYE, *Consulting Engineer, New York.*

Cost Estimating

CONSTRUCTION ESTIMATES AND COSTS—By H. E. Pulver, 653 pp. Published by McGraw-Hill Book Co., New York and London. Price $5.

For students and newcomers in the estimating field the book offers a complete text on the methods and thinking followed in estimating the cost of engineering construction generally and buildings particularly. Emphasis is placed on fundamentals by repetition in every chapter. Explanatory examples simplify the subject matter. Chapters on construction plant and job management explain general usage.

As a reference manual the book offers fundamental data and pertinent comment on most subjects, with the usual ranges of production and cost outlined as a guide in unfamiliar work. The appendix has only representative samples of the useful tables it might have contained on bidding check lists and ownership and rental rates of equipment, being largely devoted to straight line diagrams which could be easily replaced with a slide rule.

MISCELLANEOUS NOTES ON BOOKLETS AND REPRINTS

GOVERNMENT CONTRACTS are the subject of a pamphlet put out by the Fidelity & Casualty Co. of Maryland, and the American Bonding Co. of Baltimore. The pamphlet is entitled, "Matters of Procedure Under Government Contract." The author, O. R. McGuire, recently served as counsel to the Comptroller General. The present edition brings matter contained in the earlier editions up to date and includes references to important statutes and court decisions applicable to contract with the United States. Copies will be sent free to contractors and engineers concerned with government contract work.

METHODS OF PREVENTING BACKFLOW of plumbing fixtures, based on a study of this problem by the U. S. Department of Commerce, are outlined in Building Materials and Structures Report BMS 28. Copies are available from the Superintendent of Documents, Washington, at 10c.

TIMBER PILES AND CONSTRUCTION TIMBER, Manual of Engineering Practice No. 17, American Society of Civil Engineers (33 West 39th St., New York City), brings together in concise form a wide variety of information of value to those using piles and heavy timber. Included are recommended specifications for piles, timber and preservative treatment. The pamphlet sells for 35c. to members, and 70c. to non-members.

THREE SECTIONS of the annual report of the American Geophysical Union are given over to hydrology. Part II contains a symposium on floods and Parts I and IV contain the papers of the section on hydrology, including an extensive report of the snow-survey conference at Los Angeles in 1938. The Transactions of the American Geophysical Union are published by the National Research Council, National Academy of Sciences, Washington, D. C.

NEW ENGINEERING BOOKS

HIGHWAY COSTS AND MOTOR VEHICLE PAYMENTS IN MASSACHUSETTS, CONNECTICUT, RHODE ISLAND—By C. B. Breed. 216 pp. Distributed by the Trustees of the Property of The New York, New Haven and Hartford Railroad, New Haven, Conn.

LAND DRAINAGE AND FLOOD PROTECTION—By Bernard A. Etcheverry. 327 pp. Published by the Stanford University Press, Stanford University, Calif. Price $3.

AMERICAN PLANNING AND CIVIC ANNUAL—288 pp. Published by the American Planning and Civic Association, 901 Union Trust Bldg., Washington, D. C. Price for non-members $3.

(Continued on p. 80)

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CONTRACT UNIT PRICES

What contractors are bidding on different kinds of construction work

WATER DISTRIBUTION SYSTEM TEXAS

OWNER: Travis County Water Control and Improvement District No. 1, Austin, Tex.; H. H. Dickehut, president. Trimble & Bandy, Austin, Tex., engineers.

PROJECT: Constructing water distribution system beginning at south city limit of Austin, and extending 3 miles south. Approximately 54,000 l. f. of cast iron pipe required for completion.

CONDITIONS: All materials to be furnished by contractor and project to be finished in 100 working days. Rail and highway transportation facilities available. Wage rates stipulated are: skilled, $1.00 per hr.; semi-skilled, 75c.; and common labor, 40c. per hr.

BIDS: Thirteen bids were received Dec. 12, 1939, ranging from the contract low of $57,122 to $72,070.

LOW BIDDERS:

1. J. C. Truehart, San Antonio, Tex., and T. A. Caldwell, Austin, Tex. (contract) $57,122
2. W. G. Cullum & Co., Dallas, Tex. 59,203
3. Holland Page, Austin, Tex. 60,519

Item	Quan.	Unit Prices (1)	(2)	(3)
1. 8-in. cast iron pipe	2,350 l. f.	$1.63	$1.60	$1.70
2. 6-in. cast iron pipe	23,200 l. f.	1.16	1.15	1.20
3. 4-in. cast iron pipe	5,750 l. f.	1.00	.85	1.00
4. 3-in. cast iron pipe	6,300 l. f.	.70	.75	.40
5. 2-in. cast iron pipe	16,369 l. f.	.40	.45	.40
6. 8-in. gate valves	2 ea.	40.00	40.00	60.00
7. 6-in. gate valves	7 ea.	27.00	30.00	40.00
8. 4-in. gate valves	4 ea.	16.50	22.00	25.00
9. 3-in. gate valves	4 ea.	13.00	19.00	20.00
10. 2-in. gate valves	14 ea.	7.00	14.00	16.06
11. 6-in. check valves	2 ea.	27.50	65.00	40.00
12. Fire hydrants	16 ea.	60.00	55.00	75.00
13. Pump house	L. S.	500.00	725.00	500.00
14. 100-gpm. centri. pump	2 ea.	325.00	350.00	750.00
15. ¾-in. copper tubing	7,500 l. f.	.39	.40	.45
16. ⅝-in. meters and boxes	180 ea.	12.00	14.00	16.50
17. 1-in. meters and boxes	15 ea.	20.00	25.00	30.00
18. 1½-in. meters and boxes	10 ea.	33.00	40.00	45.00
19. 2-in. meters and boxes	1 ea.	53.00	60.00	80.00
20. Cast iron fittings	10 ton	145.00	150.00	150.00
21. State highway crossings	2 ea.	100.00	100.00	250.00
22. ¾-in. meter	1 ea.	14.00	20.00	20.00
23. Solid rock excav.	250 c. y.	2.50	2.50	4.75

FERN RIDGE DAM OREGON

OWNER: U. S. Engineer Office, Pittock Block, Portland, Ore.; Major C. R. Moore, engineer.

PROJECT: Constructing earth fill dam (Fern Ridge Dam) located on Long Tom River, Lane County, Oregon, about thirteen miles northwest of city of Eugene. Involves excavation for spillway and outlet structure foundation, diversion and care of river; construction of concrete overflow spillway and outlet works; construction of main earth fill dam; two earth fill dikes; spillway and outlet gates; and access roads.

CONDITIONS: Contractor to complete work in 575 working days and furnish all materials except gantry crane which is to be furnished under another contract. Rail and highway transportation facilities available. Wages specified are: skilled labor, $1.25 per hr.; semi-skilled, $1.00 per hr.; and common labor, 75c. per hr.

BIDS: Twenty bids were received March 5, 1940, ranging from the contract low of $723,592 to $1,323,471.

LOW BIDDERS:

1. Morrison-Knudsen Co., Boise, Idaho (contract) $723,592
2. Fredericksen & Westbrook, Sacramento, Calif. 743,547
3. Hanrahan Connolly Co., San Francisco, Calif. 747,470

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Diversion, care of water	L. S.	$7,500.00	$10,000.00	$1,000.00
2. Washed gravel for drains	3,000 c. y.	2.40	1.25	1.70
3. Coarse gravel for drains	13,000 c. y.	.50	.35	.50
4. Common excavation	50,000 c. y.	.26	.16	.25
5. Rock excavation	18,000 c. y.	2.00	1.50	40
6. Drill, broach rock faces	2,500 s. f.	.70	1.20	1.50
7. Foundation drain pipe	7,000 l. f.	1.60	1.50	1.50
8. Strip dam fndn. area	200,000 c. y.	.115	.12	.16
9. Borrow excavation	1,340,000 c. y.	.137	.13	.16
10. Embankmt. fill, sone 1	110,000 c. y.	.02	.02	.02
11. Embankmt. fill, sones 2 and 3	900,000 c. y.	.03	.044	.05
12. Compact fill, stream beds	50,000 c. y.	.025	.06	.03
13. Add'l. rolling, 2 trips	200,000 s. f.	.008	.01	.005
14. Backfill against struct.	3,400 c. y.	.50	1.00	1.00
15. Dump riprap, embankment	51,000 c. y.	1.10	1.75	1.10
16. Same, spillway, side slopes	8,000 c y	1.15	2.00	1.40
17. Grouted rock paving	425 c. y.	5.30	8.00	7.00
18. Rock spalls	6,400 c. y.	1.10	2.00	.70
19. Topsoil facing, embank	4,200 sq.	1.55	1.60	1.00
20. Concrete, Class A	6,250 c. y.	17.00	14.00	16.00
21. Concrete, Class B	4,100 c. y.	10.00	10.00	8.00
22. Special concrete	75 c. y.	30.00	25.00	40.00
23. Drill fndn. grout holes	660 l. f.	.50	1.50	1.00
24. Pressure grouting	200 c. y.	2.50	3.00	2.00
25. Copper seal strips	2,700 lb.	.40	.50	.50
26. Grouting compound	9,000 lb.	.12	.11	.13
27. Reinforcing steel	860,000 lb.	.045	.042	.045
28. 3x3-ft. sluice gate	L. S.	600.00	600.00	800.00
29. Concrete counterweights	L. S.	1,350.00	3,000.00	1,200.00
30. Structural carbon steel	83,000 lb.	.12	.10	.14
31. Crane rails	19,500 lb.	.07	.04	.07
32. Corrosion resist. cast steel	18,000 lb.	.60	.50	.60
33. Corr. resist. rolled steel	4,000 lb.	.60	.75	.60
34. Miscellaneous metal	37,000 lb.	.16	.15	.25
35. Pipe, fittings, valves	26,000 lb.	.15	.15	.25
36. 500-gpm. pump and meter	L. S.	500.00	500.00	800.00
37. Fuel storage tank and pump	L. S.	135.00	500.00	200.00
38. Brons expan. plates	3,000 lb.	.50	.50	.52
39. Radial spillway gates	6 ea.	7,800.00	6,700.00	8,000.00
40. Outlet gates, stop logs, etc.	L. S.	22,000.00	17,000.00	23,500.00
41. Electrical system	L. S.	5,800.00	6,000.00	4,880.00
42. Roadway excavation, common	7,000 c. y.	.20	.25	.20
43. Roadway excavation, rock	100 c. y.	1.00	1.80	.40
44. 12-in. corr. iron culvert	120 l. f.	1.80	2.60	2.50
45. 18-in. corr. iron culvert	200 l. f.	3.40	3.50	3.50
46. 24-in. corr. iron culvert	90 l. f.	5.35	4.25	6.00
47. Roadway surf., base crse	3,300 c. y.	1.00	3.00	1.60
48. Roadway surf., top crse	2,200 c. y.	1.00	3.00	2.00
49. Roadway guard posts	360 ea.	1.80	2.00	3.00
50. Barb. wire fencing, access rds.	5,800 l. f.	.07	.08	.20
51. Woven wire fencing, access rds.	5,800 l. f.	.12	.10	.30
52. Metal gates, access rds.	10 ea.	11.50	20.00	25.00
53. Control house, plumbing, san. sys.	L. S.	1,000.00	425.00	500.00

EARTHWORK, LOUISIANA

OWNER: U. S. Engineer Office, Vicksburg, Miss.

PROJECT: Construct approximately 350,000 c.y. of earthwork on east bank of Ouchita River in Caldwell Parish, La.

BIDS: Thirty bids were opened Jan. 18, 1940, ranging from contract low of $24,465 to $60,200. Engineer's estimate, $49,518.

LOW BIDDERS:

1. H. B. Hornsby, Bossier City, La. (contract). $24,465
2. Joe W. Hendrix, Alexandria, La. 24,955
3. DeLong & Tatum, Dubach, La. 27,580

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Earthwork	350,000 c.y.	$0.0699	$0.0713	$0.078